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With METALLURGICAL SUPPLEMENT.

The Engineer.

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VOL. CLIII.—No. 3976] LONDON: FRIDAY EVENING, MARCH 25, 1932 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

Ministry of Transport.

ARTERIAL ROADS—GREATER LONDON.
EAST HAM AND BARKING BY-PASS A. 116.
EXPERIMENTAL SECTION.
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The Minister is prepared to receive TENDERS for the CARRYING OUT of the above-mentioned WORKS, within the County Boroughs of East Ham and West Ham.

Forms of Tender, conditions of Tenders, conditions of contract, form of contract, bill of quantities and specification may be obtained from, and drawings may be inspected at the offices of the Chief Engineer, Roads Department, Ministry of Transport, 7, Whitehall-gardens, S.W. 1, on and after the 21st March, 1932, upon payment of a deposit of £25.

This amount will be returned to the Tenderer if his Tender is a bona fide one and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

Tenders on the official form, accompanied by a fully priced bill of quantities, and enclosed in a sealed envelope, endorsed "TENDER FOR ROAD WORKS, EAST HAM AND BARKING BY-PASS," must reach the undersigned by 10 a.m. on Thursday, the 7th April, 1932.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this 16th day of March, 1932.

J. S. POOL GODSELL,
Assistant Secretary.

Roads Department. 8307

Civil Service Commission.

FORTHCOMING EXAMINATION:—PROBATIONARY ASSISTANT ENGINEERS (MALE) in the Engineering Department of the Post Office (20-25, with extension in certain cases).

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Borough Polytechnic.

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J. W. BISPHAM,
Principal.

8310

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All those whose names are accepted for entry in the Board's Register for employment possess qualifications which have been attested by means of scientific examinations, practical training, and experience. P2188

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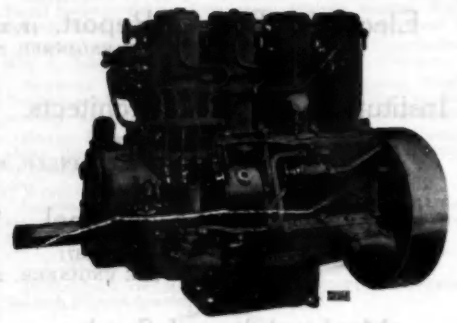

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A Seven-Day Journal

The B.E.A.M.A. Meeting.

SPEAKING at a luncheon held on the occasion of the annual general meeting of the British Electrical and Allied Industries Association, on Thursday, March 17th, Mr. V. Wallington reviewed the work of the Association as he had seen it develop during his three years' chairmanship of the Council. The Association, he said, was a model of its kind, and it was increasingly useful to the industry and to the nation. Referring to the achievements of the industry and its hopes for the future, Mr. Wallington mentioned the share the Association had taken in the Faraday celebrations and in the success of the Buenos Aires Exhibition. At the latter he had been privileged to be present and to be received by H.R.H. the Prince of Wales. He had gathered from his talk that the Prince felt that the efforts of the British trader suffered from lack of co-ordination, and it was with the idea of removing that trouble that the Association had agreed that a representative of the British electrical industry, Mr. H. Siddeley, should be sent to the Argentine. Turning to future developments he said he was convinced that electrification was the real solution to the railways' problems, but he would warn them that electrification did not mean just a substitution of one type of locomotive for another, but radical reorganisation. He mentioned, also, the Ottawa Conference. The Association had already submitted to the Imperial Conference proposals for Imperial trade co-operation, which had been described as the most practical sent to it, and it was hoped that in June those proposals would not only receive full consideration, but that some forward step would be taken. Later in the afternoon the new Council met, and Mr. N. J. Railing was unanimously elected chairman for the coming year.

Rail and Road in France.

THE dilatoriness of the French Chamber of Deputies in dealing with the situation of the railway companies threatens to have serious consequences in the immediate future. The Chamber has rejected all proposals to relieve the companies of excessive fiscal and other burdens and to allow them a free hand to deal with the road traffic competition. It has postponed for an indefinite period any acceptable solution by submitting for further consideration a Socialist scheme to transfer the railways from the companies to the State. In the debate on the Budget estimates last week it was stated that the companies' losses, including those of the State Railways, which account for the greater part of the deficit, increased from 1297 million francs in 1930 to 2586 millions in 1931, and that unless something was done immediately to save them the total deficit at the end of this year may be close upon 10,000 million francs. The railway companies themselves have made it sufficiently clear that they only need a free hand to run the railways on purely commercial lines, without State interference, and without the crushing burdens imposed upon them by the State, in order to increase the efficiency of the services and eliminate loss. Independent experts appointed by the Government have reported to the same effect. Parliament will not release its hold on the railways, which are a valuable means of distributing largesse to electors in the form of low rates, free passes, and special advantages for those who may have some excuse for claiming them, and the State declines, in the present condition of national finance, to forego any of its taxes representing one-third of the cost of passenger fares and 8 per cent. of the goods freights, or the free transport of mails and army officers and men. All this represents a loss to the companies far in excess of the deficit. The situation is now complicated by the growing competition of road traffic, which the railway companies propose to deal with in a perfectly rational and logical manner, but their plans have been rejected, even the experimental one submitted by the Compagnie du Nord for running a combination of motor cars and trains in the district around Guise. Had that ingenious plan been tried and proved successful it might have had far-reaching consequences for railway working. The only concession so far made is the suppression of the clause in the convention between the State and the railway companies requiring that a minimum of three trains shall be run daily on local lines in rural districts whether there is any traffic or not. The companies are now free to combine the local railway service with road transport.

Rail and Road.

ON January 26th, the Railway Companies' Association addressed a memorandum to the Minister of Transport dealing with the position of the railways as regards road transport. Some weeks later the road transport concerns delivered to the Minister a memorandum replying to that of the railways. In an article in our issue of March 11th we contrasted the claims of the two forms of transport. The matter has now been carried another stage forward. The Railway Companies' Association has issued a considered reply to the criticisms made by the Road. The Road's memorandum, it states, criticised the Railways for overlooking the existence of the petrol duty. The Railway's reply that the total annual cost of the highways of Great Britain is £60,000,000, towards which the motorist finds £20,000,000 and the ratepayer £40,000,000. The contention is that the ratepayer should be relieved of this payment. The existence of the petrol duty does not affect this question. The Railways refute the allegation that they benefit by relief from three-quarters of the burden of local rates under the De-rating Act by stating that at the request of the Government they undertook to pass on this relief to certain depressed industries. They state that they have obtained no benefit thereby and are in fact paying to the freight rebates fund the full charge for local rates. The suggestion was made that the licensing proposals put forward by the Railways would mean that uneconomic regulations similar to those attaching to the railways would be imposed on road transport and that the railways would do better to endeavour to rid themselves of such regulations rather than to attempt to impose them on others. To this the Railways reply that, broadly speaking, the regulations under which they work are reasonable for a public service and that road transport has now become in its turn a public service and ought to accept similar regulation. As far as conveyance of passengers by road is concerned, such regulations have already been accepted. If the Government does not consider such regulations necessary, then the Railways might fairly ask that they, too, should be liberated, but that alternative is not the one they seek.

A Road and Rail Joint Committee.

AT a meeting on March 21st between Mr. P. J. Pybus, the Minister of Transport, and representatives of the four great railway groups, the Standing Joint Committee of Mechanical Road Transport Associations, and the Long-distance Road Haulage Association, it was agreed that a committee should be set up with the following terms of reference :—" To investigate the facts relating to the total costs of the highway system, including the regulation of traffic, the incidence of those costs and the contributions of the different classes of users of mechanically propelled vehicles ; to consider and report on the nature and extent of the regulation which, in view of modern economic developments, should be applied to goods transport by road and by rail ; and, in the light of any conclusions reached under these heads, to make such further recommendations as they are able to frame designed to assist the two sides of the industry to carry out their functions under equitable conditions, which adequately safeguard the interests of trade and industry ; and to report by the end of July." The railways will be represented by Sir Herbert Walker, Sir Josiah Stamp, Sir James Milne, and Sir Ralph Wedgwood ; while goods transport by road will be represented by Mr. W. H. Gaunt, distribution manager of J. Lyons and Co., Ltd.; Mr. C. le M. Gosselin, past-President of the Commercial Motor Users Association ; Mr. E. G. Guest, President of the Scottish Commercial Motor Users Association ; and Mr. P. R. Turner, President of the London Haulage Contractors' Association.

Salving the M 2.

FURTHER to our Journal note of last week, regarding the progress made with the salvage of the submarine " M 2," we are officially informed that the work is proceeding most satisfactorily. Contrary to the statement made in our previous note, no cementing took place until last week-end, when the hatch within the aeroplane hangar was successfully sealed. Work is now almost completed in connection with the fixing of a steel plate over the conning tower opening. The hatch and conning tower patches are both furnished with compressed air connections, while in order to allow the water within the hull to escape when subjected to air pressure, a hole will be drilled or burned in the stern of the vessel. When the preparations we have referred to have been completed an effort will be made to raise the ship, which, we trust, will be rewarded by the success it deserves.

Award of the Duddell Medal.

THE Duddell bronze medal is awarded, not more frequently than once a year, by the Council of the Physical Society to persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments or by the discovery of materials used in their construction. The ninth medal has been awarded to Professor C. T. R. Wilson, and was presented to him by the President, Professor Sir Arthur S. Eddington, at the annual general meeting of the Physical Society on March 18th. The contributions of Professor C. T. R. Wilson to physical science fall mainly into two groups, those associated with the investigations of the tracks of ionising particles on the one hand, and the investigations of atmospheric electricity on the other. The study of the condensation of drops of water round ionic and other nuclei led him to the invention and perfection of his expansion apparatus, one of the most potent instruments of physical investigation ever devised. The work of Professor Wilson in atmospheric electricity has opened up a new and profitable field of inquiry. His method of studying rapid changes of the earth's electric field has led to a great increase in knowledge of the electric fields associated with thunderstorms. By studying the electric field changes at short distances from discharge channels Wilson made the first reliable determination of the magnitude of the electric charge dissipated in a lightning flash ; and Appleton and Schonland, working at greater distances, have established the correctness of his view that thunder clouds are predominantly bi-polar, the positive charge being elevated above the negative charge. This work, together with Wormell's study of point discharges in thunderstorm fields, has led to overwhelming evidence in favour of Wilson's solution of the problem how the earth's electric charge is maintained. The persistence of the earth's negative charge in fine weather regions, in spite of the dissipative action of the positive ion current constantly flowing from the air to the ground, can now be attributed to the action of thunder and shower clouds, the charges of which are so disposed as to send negative electricity into the ground in sufficient quantity to balance the dissipation.

The Galloway Water Power Scheme.

A CONTRACT representing £300,000 for the construction of a concrete tunnel through the Galloway hills at Glenlee in connection with the hydro-electric works in the South of Scotland has been placed with A. M. Carmichael, of Edinburgh, by the Galloway Water Power Company. The tunnel will be bored through rock, and the contract will give work to 500 men for about two and a-half years. A dam will be built in order to flood a glen with water from the river Dee, and the tunnel will take the water from the dam to the power-house at Glenlee. Before the work begins, a committee appointed by the Secretary of State for Scotland, under the Companies Act, and consisting of Lord Hamilton of Dalzell, Mr. H. O. Tarbolton, and Mr. Milne Horne, will inspect the area and take steps to ensure that its natural beauty shall not be damaged. It is claimed that the amenity of the valley will be improved by the loch, which will be the result of the construction of the dam. The Glenlee station is one of the five to be built by the Galloway Water Power Company at different points in the Galloway district. About 140,000 horse-power will be produced by the water, and the stations will be connected with the " grid," so that they may be used to meet sudden demands for additional power.

The Mersey Tunnel.

IN a Journal note published in our issue of February 26th, we referred to the statement of Sir Thomas White, the chairman of the Mersey Tunnel Joint Committee, to the effect that the total cost of the tunnel, including the ventilation plant, will exceed by about one and a-half million pounds the original estimated cost. In view of the situation it was decided to make representations to the Government with a hope of obtaining a further grant from the Ministry of Transport. At a meeting of the Committee, held in Liverpool on Monday last, March 21st, a letter was read from the Minister of Transport, in which it was stated that there was no likelihood of resources being at his disposal from which an additional grant could be made, and he was unable to hold out any hope of further assistance. After the meeting it was stated that the Committee had given orders for further information on the question of tolls and other matters to be prepared, and when such information was available the Committee would proceed to consider what action was desirable.

Shipyard Wages and Working Conditions.

A CONFERENCE of all the executive committees of shipyard trade unions was held in London on Monday last, in order to consider the shipbuilding employers' appeal for co-operation in the reconsideration of several working arrangements, which the employers believe will, without interference with basis wage agreements, improve the competitive ability of the industry. The employers recently made representations to the trade unions pointing out that present allowances are excessive, and in some cases are not in keeping with the conditions of industry, while it is also necessary to remove some of the hindrances to the further introduction of machinery and to facilitate the interchangeability of labour, both in shipbuilding and repair work. The Conference lasted about two hours, and it revealed differences of opinion between the representatives of skilled and unskilled labour. Mr. John Hill, of the Boilermakers' Society, together with Mr. W. H. Hutchinson and Mr. A. B. Swales, of the Amalgamated Engineering Union, were opposed to taking any step which might appear to concede the principle of the claims, while the representatives of the unskilled men, on the other hand, were desirous of hearing details of the employers' proposals. At the close of the Conference it was announced that it had been decided to write to the Shipbuilding Employers' Federation requesting further information as to its proposals.

SYDNEY HARBOUR BRIDGE—APPROACH SPANS

DORMAN, LONG AND CO., LTD., MIDDLESBROUGH, CONTRACTORS

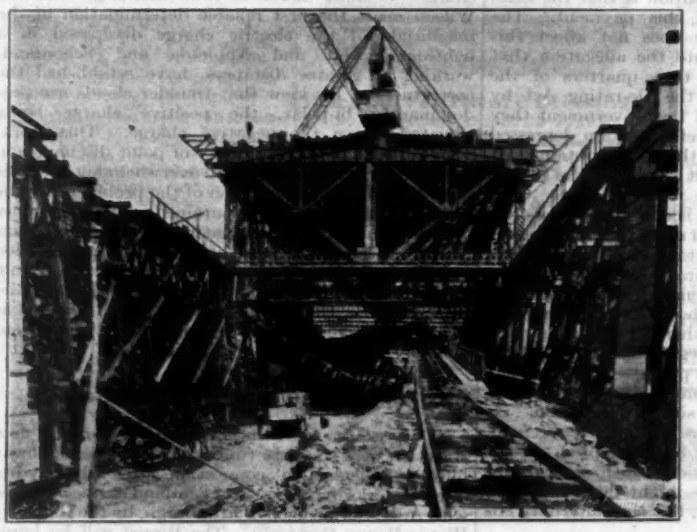

Fig. 5—Dawes Point, Span 1—March 11, 1927

Fig. 6—Dawes Point, Deck Steelwork, Spans 1 and 2—June 28, 1927

Sydney Harbour Bridge.

No. II.*

Specification Requirements and Materials.

In the specification prepared by Dr. J. J. C. Bradfield, Chief Engineer of the New South Wales Public Works Department, the loadings and working stresses to which the contractors had to work were defined, but within the limits specified the choice of steel or combination of steels to be employed in the different parts of the bridge was left to the contractors.

The following are the particulars of the specified loadings :—

Live Loads.

Footway.—100 lb. per square foot.

Roadway.—Conventional motor lorry, 12ft. by 6ft. wheel base, in any position, occupying a space of 30ft. by 12ft. Front axle, 18,000 lb.; rear axle, 36,000 lb. Remainder of roadway, 100 lb. per square foot.

Railway.—On each track two locomotives, each 65ft. long, weighing 360,000 lb., followed by a train weighing 2200 lb. per foot. Maximum axle load of locomotive, 56,000 lb.

Main Arch Trusses.—6000 lb. per lineal foot on each truss for a length not exceeding 1100ft. nor less than 300ft. [Note.—There is no live load on the arch trusses apart from the live loads transmitted to them from the deck. The aggregate of the specified live loads on the footways, roadway, and railway tracks exceeds 8000 lb. per lineal foot per truss. It is understood that the trusses were designed on the assumption that the live load transmitted to each of them would never reach this aggregate value, and that it could be taken as being 6000 lb. per lineal foot.]

Approach Span Trusses.—10,000 lb. per lineal foot on each main truss; 9000 lb. per lineal foot on each main truss of span No. 1.

Impact.

Percentage addition to live load stresses to cover impact effect :—

	Stringers.	Cross girders.
Deck System.—		
Railway loads	50%	40%
Roadway loads	25%	20%
Main Trusses.—Arch	10%	
Approach spans	20%	

Wind.

(*a*) *Normal to Bridge.*—30 lb. per square foot on the exposed surface of the two trusses and on 1½ times the elevation of the floor. 150 lb. per lineal foot on the footway fence. 30 lb. per square foot on travellers and falsework [*i.e.*, on creeper cranes, timber staging, &c.]

(*b*) *Parallel with Bridge.*—30 lb. per square foot on one-half the area assumed in (*a*) [*i.e.*, the area exposed to a wind blowing parallel with the bridge was to be assumed as equal to half the area exposed to a normal wind].

(*c*) *Moving Loads.*—300 lb. per lineal foot applied 7ft. above the base of the rail.

Temperature.

Temperatures to be assumed in calculating temperature stresses :—

(*a*) A variation of 60 deg. above or below a mean temperature of 70 deg. Fah.

(*b*) A difference of 50 deg. Fah. between the temperature of steel and masonry.

(*c*) A difference of 25 deg. Fah. between the temperature of an outer web exposed to the sun and that of the inner webs of compression members.

Traction.

A longitudinal force of 650 lb. per lineal foot for both tracks carrying traffic in the same direction.

Friction.

The tangential force produced by the rotation of a pin in its pinhole to be assumed to be 33⅓ per cent. of the force on the pin [the force on the pin being taken as acting at the radius of the pin].

Centrifugal Force.

The northern approach spans to be designed to provide for the forces produced by trains on each of the two tracks in the same direction, the force to be taken as applied 5ft. above the base of the rail.

Three alternative combinations of external loads and forces were specified to be used for the purpose of determining the areas of the bridge members.

Alternative No. 1 (with primary unit stresses).—
Dead load, live load, and impact.
Longitudinal force and centrifugal force.
One-third wind load.
Temperature stresses (*a*) and (*b*).

Alternative No. 2 (with primary unit stresses).—
Dead load, three-quarters live load, and impact.
Longitudinal force and centrifugal force.
Full wind load.
Temperature stresses (*a*) and (*b*)

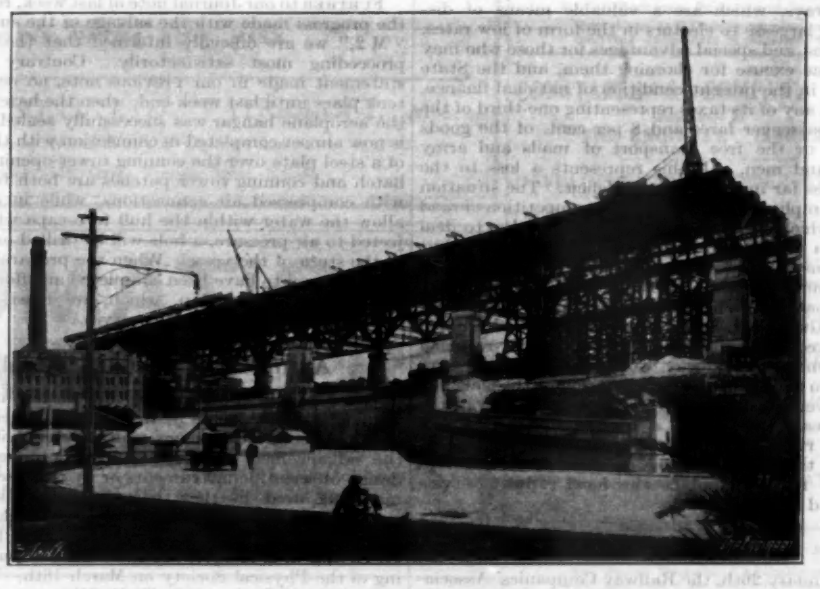

Fig. 7—Dawes Point, Spans 1, 2, 3 and 4

Alternative No. 3 (with secondary unit stresses).—
Dead load, live load, and impact.
Longitudinal force, friction, and centrifugal force.
Wind load.
Temperature stresses (*a*) and (*b*).
All secondary stresses.

The specified working stresses, in pounds per square inch, were as follows :—

Riveted Members.—

	Silicon steel.	Carbon steel.
Tension	23,500	18,000
Compression—		
$l/r < 50$	17,500	14,000
$l/r > 50$	$22{,}500 - 100\,l/r$	$18{,}000 - 80\,l/r$
Shear in webs of plate girders	13,000	10,000

Rivets.—

	Power driven.	Hand driven
Bearing	22,000	20,000
Shear	12,000	11,000

As already indicated, the steel used in the construction of the bridge was of two qualities, silicon steel and ordinary or carbon steel. Silicon steel was used throughout the trusses of the arch span, for the flanges of the cross girders of the main span, and for the diagonal members of the lateral bracing of the arch on the lower chords, except in panel 28–26.* The rest of the structure, including the approach spans, the whole of the deck structure, and the remaining portions of the lateral bracing, was fabricated of carbon steel. The rivets were of a softer quality of carbon steel. Special steels were used for the bearings and pins. Both the carbon and the silicon steels were subjected to bend tests on specimens cut in the

* No. I. appeared March 18th.

* For the key to the numbering of the arch members see Fig. 3 in last week's issue.

direction of rolling and transversely to it, and had to show the following physical properties :—

	Silicon steel.	Carbon steel.
Ultimate tensile strength, lb./sq. in.	80,000/95,000	62,000/72,000
Minimum yield point, lb./sq. in.	45,000	35,000
Minimum elongation, per cent. on 8in.	1,600,000 / Ultimate	1,500,000 / Ultimate
Minimum reduction of area, per cent.	35	40

The rivet steel was required to show an ultimate tensile strength of 53,800 to 62,700 lb. per square inch, a minimum yield point of 31,400 lb. per square inch, an elongation of (1,500,000 ÷ ultimate strength) per cent. on 8in., and a minimum reduction of area of 50 per cent.

The specified unit stresses on masonry and concrete were as follows :—

Granite	800 lb./sq. in.
Concrete 1–2–4	500 "
Concrete 1–2–5	450 "

APPROACH SPANS.

In Dr. Bradfield's specification the approach spans, four in number at each end of the bridge, were represented as consisting of four main girders in each span, resting on massive masonry piers, extending across the full width of the bridge. The contractors succeeded in effecting a substantial economy by increasing the number of spans in each approach to five, by reducing the number of main girders in each span to two, and by substituting two relatively small independent piers for each proposed pier of full width. Each span measures approximately 170ft., except the end span at the extreme south, which was made 238ft. in order to clear an existing road.

The construction of the approach spans is illustrated in Fig. 8, and their erection in Figs. 5, 6, and 7. All the approach spans are similar throughout. The main trusses have chords of box section laced top and bottom, with plated covers on the top side of the top chord. The web members of the main trusses are of similar construction, except in the case of the tension verticals which are of single web section. At all the panel points the trusses are braced transversely. In addition, the upper chords are braced laterally, but there is no lateral bracing on the lower chords. Each main truss is carried on two cast steel bearings supported on granite-faced concrete piers, the concrete foundations of which are carried down to sandstone rock. Of the two cast steel bearings of each truss, one is fixed and the other is free to slide on bronze liners.

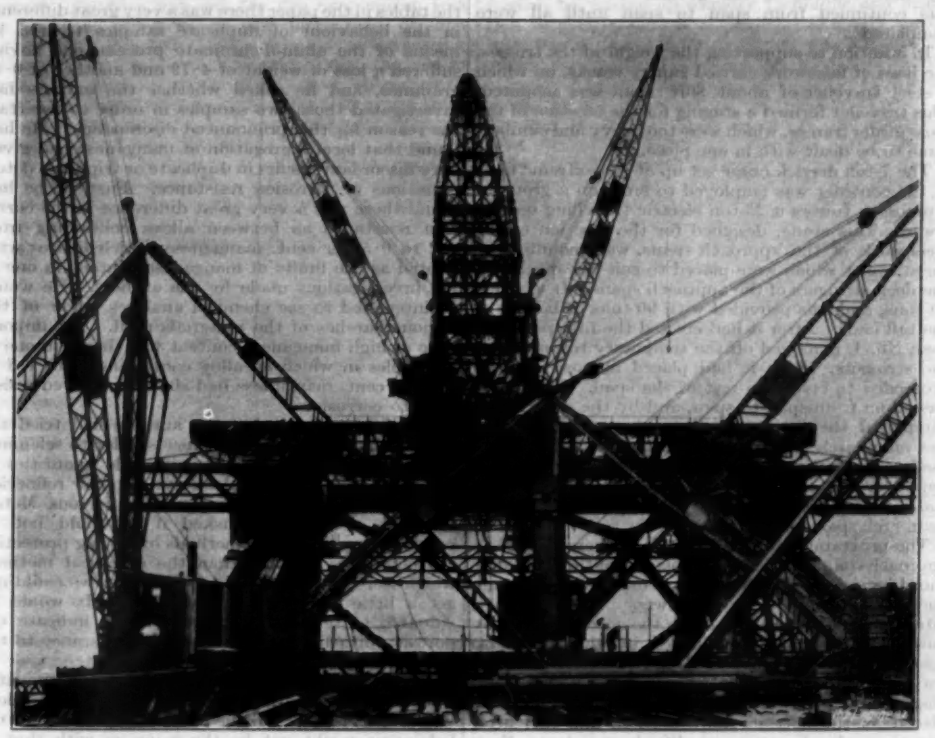

FIG. 9—25-TON TRAVELLING CRANE ERECTING CREEPER CRANE—JANUARY 21, 1929

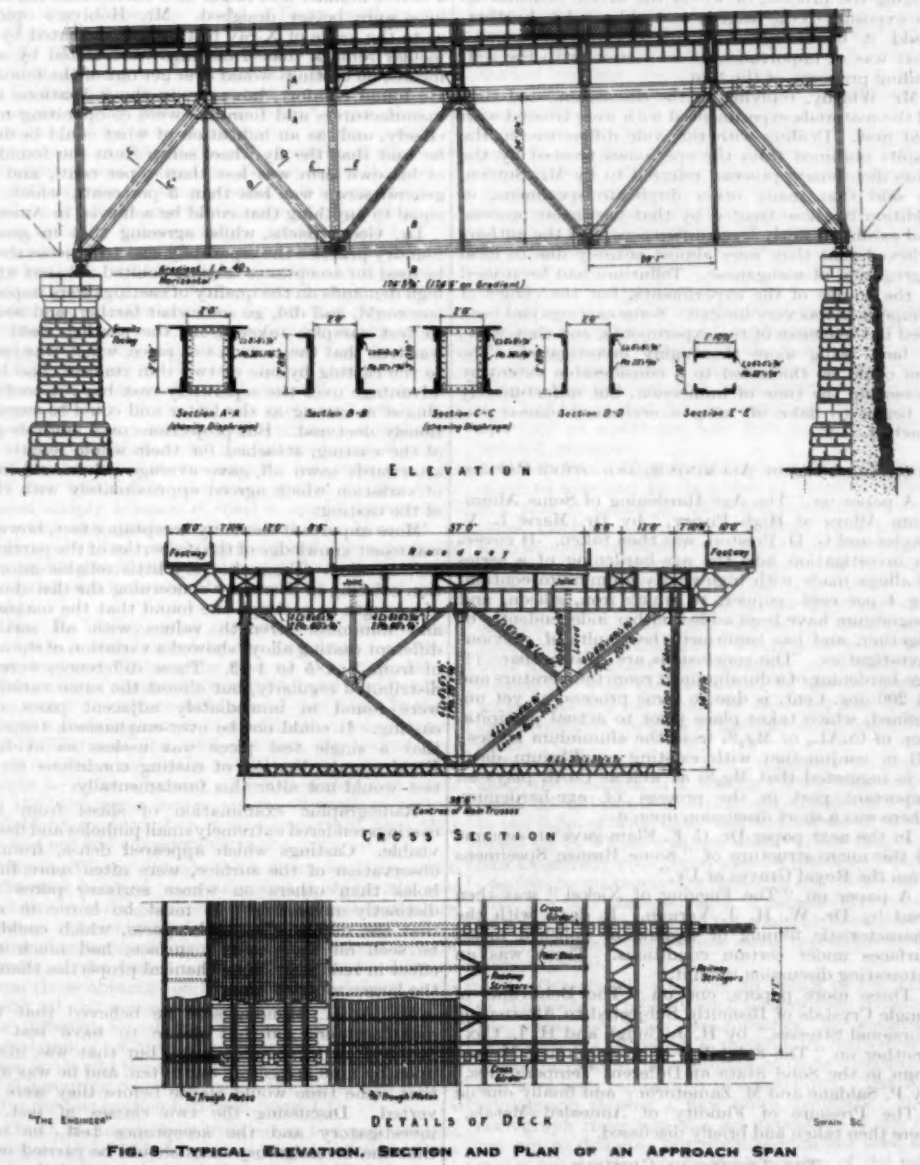

FIG. 8—TYPICAL ELEVATION, SECTION AND PLAN OF AN APPROACH SPAN

On top of the main trusses there rest plated cross girders, which are supported intermediately by transverse frameworks, which extend to the full truss depth. At each end of the cross girders cantilever brackets support the footways. The stringers for the roadway and railway tracks rest directly on top of the cross girders. The rest of the details of the deck construction are similar to the corresponding details of the deck construction of the main arch span, and will be described when we come to deal with that span.

As already noted, the land on each side of the harbour slopes upwards from the water edge. At the extreme north and south ends of the contract it reaches a height of about 60ft. Up each of these slopes a standard gauge haulage incline, 1300ft. long, was laid along the centre line of the approach spans. These inclines were operated by 10-ton electric haulage winches, which were capable of hauling loads up to 70 tons. At the water edge the inclines terminated on timber wharves, to which the material manufactured in the shops was transported by water, and at which it was unloaded by means of 25-ton derrick cranes. At both approaches the process of erection was the same as that which we are about to describe, but the work at the northern approach was always some months behind that at the southern. The reason for the difference lay partly in the fact that access to the northern site was obtained at a later date than to the southern site, and partly in the fact that dissimilar progress suited the output of the shops. In fact, throughout the whole construction of the bridge the general scheme of erection called for the work at the south end to precede that at the north.

Erection of the approaches began with the setting up of a 7-ton derrick crane at the extreme end of the contract. With this crane, the concrete for the terminal abutments of span No. 1 was placed. Thereafter, a 5-ton steam locomotive crane was erected on each of the two abutments. These cranes were then employed to construct two lines of timber falsework, composed of 12in. by 12in. Oregon timber, and designed to carry the weight of the approach spans while they were being assembled. The falsework took the form of a row of independent towers spaced about 30ft. apart, in order to coincide with the panel points of the trusses. The towers in each row were well braced together longitudinally. As far as possible, the towers were constructed of standard units in order that they might be used in successive spans. They varied in height between 50ft. and 90ft. to suit the contour of the ground. As the falsework progressed each crane moved forward on what was done until all was completed for the first span. At that point it was next employed to excavate for the foundations of and build the next concrete pier. When the piers were completed, the locomotive cranes passed over them on steel tracks and began the erection of the timber falsework for span No. 2. Timber falsework for two spans at each end of the bridge was provided. While the riveting of No. 1 span was being completed the erection of span No. 2 was being carried out. Thereafter the falsework of span No. 1

was dismantled, and re-erected for span No. 3, such modifications being made as were required to suit the new contour of the ground. This procedure was continued from span to span until all were completed.

In addition to supporting the weight of the trusses, the lines of falsework carried gantry tracks, on which a steel traveller of about 80ft. span was mounted. This traveller formed a staging for the erection of the cross girder frames, which were too heavy and cumbersome to be dealt with in one piece.

The 7-ton derrick crane set up at the extreme limit of the contract was employed to erect on a group of temporary towers a 25-ton electric travelling derrick crane. This crane, designed for the erection of the steel work of the approach spans, was mounted on three bogies which were placed to suit the spacing of the deck stringers of the approach spans. It weighed 80 tons, and was provided with 90 tons of ballast at the tail ends. After it had erected the first panels of span No. 1, it moved off the temporary towers on to the stringers, which it had placed in position, and proceeded to erect the rest of the span. This crane passed on from span to span, and by the time it had completed the fifth span the pylon at the end of the main arch had reached deck level, and it was used to erect the deck steel work of the pylon. Subsequently the crane was run on to the pylon deck, and was employed to erect the creeper crane for the main arch span—see Fig. 9.

The programme of operations for the erection of an approach span began with the placing of the first lower chord section—about 60ft. long—on the pier bearing, and two of the falsework towers. This member, after it had been blocked up to the correct height by means of wedges, was followed by the transverse bottom tie, which was placed in position on the steel traveller spanning the falsework. The vertical and diagonal members of the main truss panel were next placed on the bottom chord section, and thereafter the upper chord section was lifted into place. Each member as it was erected was secured by pinning about one-third of the rivet holes and bolting another third.

A panel of each main truss having been assembled in this manner, the cross girder frame between the trusses was built up on the lower transverse tie, which was already resting on the steel traveller. Of this frame, the centre post and diagonals were erected first and thereafter the box-sectioned upper chord, delivered to the site in two pieces, was placed in position. After the cross frame had been completed, the roadway and railway stringers were added. The 25-ton travelling derrick crane was thereupon enabled to pass on to the panel just erected, and begin the erection of the next panel of the span.

Following the 25-ton travelling crane, there came a 5-ton electric derrick crane, by means of which the lighter portions of the steel deck structure were erected. This crane lifted the footways in completely assembled and riveted lengths of about 30ft., and also dealt with the roadway troughing and the lattice work parapets.

(To be continued.)

The Institute of Metals.

No. II.*

Selenium as a Protective Coating.

On Thursday a paper entitled "Magnesium Alloy Protection by Selenium and other Coating Processes" was presented by G. D. Bengough and L. Whitby.

The paper refers to a process which has been developed for the production of films of selenium on several light magnesium alloys. These films confer considerable resistance to the corrosive action of sea-water spray. They are normally produced by immersion for a few minutes in a bath containing selenious acid at laboratory temperature, but may also be produced by rubbing the alloy with porous material dipped in the bath. It has the property of self-healing to a limited extent, especially when immersed in stagnant sea water, is only a few thousandths of a millimetre thick, and forms a satisfactory base for certain types of paint. Dr. Bengough added that the crab in the process was the cost of the selenium. The sources of supply were the anode slimes and sludge chambers in the making of lead sulphuric acid. The output was gradually increasing, and there were considerable stocks. The present demands for selenium and selenious compounds came mainly from the rubber and the glass industry, but the amount required for the filming process was very small, owing to the extreme thinness of the selenium film required for protection purposes. He did not think there was any cause to worry about the supply.

Mr. H. Sutton (Royal Aircraft Establishment, Farnborough), opening the discussion, welcomed the process as being of great scientific interest, and one which appeared to be capable of useful technical application. There seemed, he said, to be some accumulation of evidence to show that the cleaning of the surface of wrought magnesium alloy in nitric or sulphuric acid, and the consequent removal of the surface layer of the alloy—usually more or less contaminated by foreign matter worked into it during manufacture—had a pronounced benefit on the corrosion resistance. He pointed out that in one of the tables in the paper there was a very great difference in the behaviour of duplicate samples treated by means of the alum-dichromate process, one having suffered a loss of weight of 4·72 and another of 0·42 grammes, and he asked whether the authors had investigated those two samples in order to ascertain the reason for this pronounced discrepancy. He had found that local segregation of manganese had given very discordant results in duplicate or triplicate determinations of corrosion resistance. Further, he had found there was a very great difference in the corrosion resistance as between alloys containing from 0·2 to 0·5 per cent. manganese, which figures were quoted as the limits of manganese content in one of the investigations made by the authors. He would be interested to see chemical analyses made of the various batches of the materials used. The importance of high manganese content was shown in one of the tables in which an alloy containing from 1·3 to 1·7 per cent. manganese had shown improved resistance to corrosion.

Mr. Atkinson asked if the authors had tried the use of tellurium, which was very similar to selenium, and of which there were considerable quantities in the anode slimes in the electrolytic copper refineries.

Dr. R. S. Hutton (Director, Non-ferrous Metals Research Association), asked if it would not be possible to evolve some methods of testing protective coatings more rational than the empirical methods which were still employed, and whether we could not get a little nearer to fundamentals. It would be valuable to devise tests which would indicate the porosity of a film and its chemical resistance to the corrosive action.

Dr. W. Rosenhain asked if the alloys experimented with included castings, because magnesium alloys were used largely in the cast condition, and the behaviour might not be the same as with that of specimens in the wrought condition. Discussing the actual deposition of the protective film, he asked whether it reached a limiting thickness very quickly; in other words, could one obtain in a few seconds a film giving as much protection and having as great a weight and thickness as could be obtained by prolonging the process, or would the action continue as the exposure to the reagent was prolonged? Further, could it be strengthened by electrolytic action? That was of importance in connection with the self-healing property of the film.

Mr. Whitby, replying to the discussion, said that all the materials experimented with were treated with acid first. Dealing with the wide differences in the results obtained from the specimens treated by the alum-dichromate process, referred to by Mr. Sutton, he said that many other duplicate specimens, in addition to those treated by that particular process, had exhibited fairly large differences, and the authors believed that they were almost entirely due to local segregation of manganese. Tellurium had been used in the course of the experiments, but the choice of compounds was very limited. Some castings had been used in the course of the experiments, and they were, in fact, being more thoroughly investigated. The film could be thickened to a considerable extent by increasing the time of immersion, but unfortunately it began to flake off after a certain thickness was reached.

Age-hardening of Aluminium, and other Papers.

A paper on "The Age Hardening of Some Aluminium Alloys of High Purity," by Dr. Marie L. V. Gayler and G. D. Preston, was then taken. It covers an investigation into the age-hardening of a series of alloys made with high-purity aluminium containing 4 per cent. copper, to which iron, silicon, and magnesium have been added, either independently or together, and has confirmed the results of previous investigators. The conclusions are drawn that—(1) age-hardening of a duralumin at room temperature and at 200 deg. Cent. is due to some process, as yet undefined, which takes place prior to actual precipitation of $CuAL_2$ or Mg_2Si from the aluminium lattice; (2) in conjunction with existing equilibrium data, it is suggested that Mg_2Si as well as $CuAl_2$ plays an important part in the process of age-hardening. There was a short discussion upon it.

In the next paper Dr. C. F. Elam gave an account of the micro-structure of "Some Bronze Specimens from the Royal Graves at Ur."

A paper on "The Fogging of Nickel" was then read by Dr. W. H. J. Vernon. It deals with the characteristic filming or fogging of polished nickel surfaces under certain conditions. There was an interesting discussion upon it.

Three more papers, one on "The Behaviour of Single Crystals of Bismuth, Subjected to Alternating Torsional Stresses," by H. J. Gough and H. L. Cox; another on "The Solubility of Aluminium in Magnesium in the Solid State at Different Temperatures," by P. Saldane and M. Zamotorin; and finally one on "The Pressure of Fluidity of Annealed Metals," were then taken and briefly discussed.

The Testing of Castings.

The remainder of the last session was devoted to a general discussion on the testing of castings, which was opened by Dr. W. Rosenhain (Past-president).

His paper summarises some of the principal points under discussion in regard to the testing of castings. Attention is confined to what is termed specification testing and control testing, leaving aside investigatory testing. Ideal methods of non-destructive testing being as yet unavailable, the application of the usual mechanical tests to castings is considered. The use of actual castings, or pieces cut from them for such tests, or the alternative use of specially cast test bars, is considered in view of the fact that the properties of castings frequently vary from place to place in the same piece. The author favours the adoption of a separately cast test piece, the use of small samples cut from actual castings being reserved for investigatory purposes. The use of chill-cast and sand-cast test bars is discussed with special reference to the forthcoming adoption of a standardised sand-cast test bar for the light alloys of aluminium. Reference is also made to the difficulty of determining small percentage elongations, and the author's suggestion that the practice followed in cast iron testing of using bending tests in which deflection is measured as a means of testing ductility, is described. Reference is also made to the discussion on the "Testing of Cast Iron," which took place at the Zürich Congress of the New International Association for Testing Materials, and the author's summary of that discussion, prepared by him as Chairman, is given as an appendix to the paper.

In conclusion the author discusses the value of tensile testing and the desirability of improving methods of testing in the interests both of the user and the manufacturer.

Mr. J. B. Hoblyn, who expressed, amid laughter, his appreciation of the fact that Dr. Rosenhain had at last presented a paper which he (Mr. Hoblyn) could understand, opened the debate. He said that he had no use for the sand-cast and chill-cast test bar, and that visual examination of castings in the inspection department was better than any examination of sand-cast and chill-cast bars. If one machined a malleable iron or cast iron test bar and found it to be full of blow-holes, what could one do? To emphasise his point he exhibited photographs of a number of castings containing various kinds of defects—which examples prompted Dr. Rosenhain to remark that Mr. Hoblyn might obtain castings from a better founder and might also ensure that the castings were better designed. Mr. Hoblyn's opinion as to the value of X-ray testing was indicated by his jocular remark that if castings were tested by such means, no castings would ever get out of the foundry. He found comfort, however, in the indications that manufacturers and founders were co-operating more closely, and, as an indication of what could be done, he said that the fly-wheel scrap from the foundries of his own firm was less than 1 per cent., and the general scrap was less than 5 per cent., which was equal to anything that could be achieved in America.

Dr. Georg Sachs, whilst agreeing that in general foundry practice the separately cast test pieces should be used for acceptance testing, pointed out that where high demands on the quality of castings were imposed, one could, and did, go somewhat farther, and sought to test samples taken from the casting itself. It was true that the cast-on test piece, which was joined to the casting by one or two thin runners, had little advantage over the separately cast bar; it could be almost as strong as the latter and could be surreptitiously doctored. But projections on a suitable part of the casting, attached for their whole length and afterwards sawn off, gave average values and limits of variation which agreed approximately with those of the casting.

More important than any acceptance test, however, was exact knowledge of the properties of the particular casting alloy. From the very little reliable information existing in literature concerning the distribution of strength in castings one found that the maximum and minimum strength values with all sorts of different casting alloys showed a variation of the order of from 1 : 1·5 to 1 : 3. These differences were not distributed regularly, but almost the same variations were found in immediately adjacent parts of a casting. It could not be over-emphasised, therefore, that a single test piece was useless as evidence. Rigid standardisation of casting conditions for the test would not alter this fundamentally.

Radiographic examination of slices from large castings rendered extremely small pinholes and fissures visible. Castings which appeared dense, from the observation of the surface, were often more full of holes than others on whose surfaces pores were distinctly noticeable. It must be borne in mind that the minute fissure-like pores, which could not be seen on the polished surface, had much more effect in reducing the mechanical properties than had the larger rounded ones.

Mr. A. H. Mundey said he believed that most manufacturers did not desire to have test bars fastened on to their castings, but that was insisted upon by nine inspectors out of ten, and he was afraid that some time would elapse before they were converted. Discussing the two classes of test, i.e., investigatory and the acceptance test, he urged that the investigatory tests should be carried out in the early stages so that the designer and the manufacturer would know all about the strengths and qualities of the material throughout the casting. The acceptance test should be made on the material

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itself as material, and not as part of the casting. He had obtained altogether different results of tests made on various parts of large castings; thus, the results of the tests were not truly indicative of the quality or the properties of the material as material. He urged co-operation between designer and metallurgist. One of the greatest troubles in the foundry was not the production of inherently bad material, but of unsound material. A very large number of the most important castings to be handled had to be subjected to air or water pressure, or, perhaps, both, and hydro-pneumatic pressure was probably the most severe that was imposed on castings.

Dr. G. Shearer amplified Dr. Rosenhain's remarks as to the possibilities of applying X-ray testing, by exhibiting a number of X-ray photographs.

Engineer Rear-Admiral Mark Rundle, D.S.O. (R.N., ret.), speaking from an inspector's point of view, said that the practice of using separately cast test bars might introduce difficulties in cases where a large number of castings had to be dealt with, because, unless an inspector was sure of the honesty of the foundrymen, it would be difficult for him to assure himself that particular test bars related to particular castings; he would have to be present when the castings were turned out. He emphasised the importance of applying to a casting, whenever possible, a test under conditions of a similar nature to those it would have to meet in practice.

Mr. R. H. Harry Stanger (President, Institution of Structural Engineers) drew attention to the fact that tests on cast iron were carried out as a rule on specimens as cast, and he had often wondered why the specimens should not be tested also in the machined condition, inasmuch as the cast iron had to be machined before use; in the case of the transverse test, for example, there was a difference in the deflection. He pointed out that non-ferrous specimens were machined as a rule. As an inspector he had always found that the foundrymen were honest; that being the case, he personally preferred a separately cast specimen to one cast on. With regard to the inspection of steel castings, he said it was his practice to have them slung and hammered. On one occasion an inspector had rejected a large number of rather heavy castings. When slung on two slings they had sounded dull, as though cracked, but when they were slung from one it was found that they were absolutely sound. Those castings were still in use.

Mr. A. J. Murphy suggested that although few at that meeting would dispute Dr. Rosenhain's view in favour of separately cast test bars, there was still a vague feeling prevailing in wider circles that the cast-on bar did give an indication of the quality of the casting as distinct from the quality of the metal of which it was made. He did not think the cast-on bar was advocated simply because it showed that the metal tested was exactly the same as that which had gone into the main casting. Another aspect of the question was that it was often not possible so to locate a cast-on bar as to ensure that the metal there was adequately fed during solidification. Further, there was sometimes a real danger that the test bar cavity, which was never provided for in the original design of casting, might act as a dirt trap during the pouring operation. He also urged that we should have to face the problem of controlling the amount of gas in light alloys. It was quite well established that there were certain chill-castings—complicated die castings—that could not be made satisfactorily with material which was entirely free from gas. He did not mean that one was entitled to use gassy metal simply because it filled a mould, irrespective of what the inside of the metal was like, but an aluminium alloy containing gas could give a perfectly satisfactory chill-casting, although that same material if tested in a loose sand bar would be rejected every time.

Mr. R. Deeley, who supported Dr. Rosenhain's contention with regard to the separately cast sand test bar said that in the case of aluminium-silicon alloys, it was absolutely essential, from the specification point of view, to have a sand-cast bar. In those alloys a certain amount of modification was obtained by chilling and the chill-cast test bar would give high results, whereas the casting which it represented might be extremely poor. He hoped that as a result of the discussion better means of testing castings would be evolved, but it was important that they should not add considerably to the costs.

Mr. A. Wragg did not think there was very much difference between a cast-on and a separately cast test bar in castings of, say, gun-metal and manganese bronze. One might be able to prove the material by using standardised separately cast test bars, but the results of the test on a casting might be different from those obtained on the standard test bars as the result of differences in the technique of casting at the different foundries. If one had a ladle full of metal and a lot of small castings had to be produced from it, should the test piece be cast at the beginning of the pouring operation, when the metal was hot, or after the last casting had been poured?

Dr. D. H. Ingall dealt with one or two unsoundness tests, and particularly porosity tests, which had not been mentioned by Dr. Rosenhain. The first was the dye penetration test, which he believed was employed to a certain extent in America. Petrol containing a dye, such as methylene blue was painted or sprayed on the side of the casting, of which the section was not too thick, and the other side of the casting was examined for penetration of the dyed petrol. Another test was the dye evaporation test, in which alcohol coloured with picric acid, or some other bright dye, was placed on the side of the casting. This surface was wiped more or less dry, the casting was put into a warm place, and subsequently examined for exudation of the dye. Pressure tests, in which the penetration of water under pressure was measured, were also described.

Mr. George Mortimer, after emphasising the need for international agreement on various matters, including the problem of test bars, said he was emphatically in favour of the use of separately cast bars. It was a great mistake to assume that identity was necessarily accomplished by an integral bar. A stringent test which would enable one to detect porous areas, or a sink or a draw, was to sand-blast a casting all over. Almost any expense would be justified, he said, to provide a means whereby it was possible to ensure a high degree of soundness. Mr. Mortimer associated himself with Dr. Rosenhain's remarks concerning X-ray examination, and added that the same remarks applied to density tests. It was not only necessary to know when a casting was unsound, but it was also necessary to know the extent, the location and the type of unsoundness before the trouble could be put right; neither X-ray nor density measurements gave a real insight into those matters.

Mr. R. Genders said, with regard to the testing of ductility, that the measurement of small elongations on tensile test pieces was admittedly unsatisfactory, but it was questionable whether the information to be gained from bend tests would be much more valuable. With relatively brittle materials the total deflection of the bend test piece before fracture was small, and represented the sum of the elastic deflection, calculated to be of the order of 0·2in. for a bar of aluminium 12in. long and 0·5in. square, and the small amount of permanent deformation undergone between the elastic limit and fracture. Therefore, the addition of the bend test to those already in use should only be made when full investigation had provided proof of its value. It should be added, in its favour, that the bend test could be made on the material as cast, and difficulties caused by test pieces fracturing at inconvenient positions were then avoided. For information as to the number and disposition of cavities there was no more certain method than the use of X-rays—he had in mind the shadow method, not the spectroscopic. It should be practicable, for each design of casting required in numbers, to take trial castings for density and X-ray tests, and to arrive, without undue expense, at a pattern, complete with runners, &c., that would produce the best result under certain casting conditions, which would ultimately be specified. It might not be possible or economical to install large numbers of testing equipments, but with properly organised co-operation in the different branches of the foundry industry such a plan for the improvement of the product would appear reasonable.

Perhaps one of the most fruitful causes of defective castings was the tendency to save scrap and labour in trimming at the expense of the runners and risers. A firm of hydraulic engineers, having experienced considerable trouble with steel castings some years ago, had found that the most successful founder used a weight of metal not less than twice that of the finished castings.

Mr. H. W. G. Hignett pointed out that good results could be obtained by variation of foundry methods, and that it might be advisable sometimes to vary those methods; but if a standard sand test bar were adopted, certain of the details would be definitely fixed, and there would be no opportunity for adjustment. It seemed to him that a test bar whose casting conditions were left to the discretion of the founder, so that he could obtain the best possible figure for a particular alloy, would give results which were more constant and, therefore, more suitable for correlation with the properties of the casting. In some cases the bar would be chill-cast and in some cases sand-cast, vertical or horizontal, with or without risers.

The President said that engineers wanted to know the strength of a casting. They would like to break up and test one casting and consider the design in the light of what they had learned from the tests made on it. That was the ideal. Then they would like a carefully considered cast-on piece, and then, if possible, to make another break-up test of the casting with the test piece on, and if necessary, reconsider where it should be put. That could be done, and was done, in certain cases where many repetition castings were required.

Mr. Gratebatch, speaking on behalf of Dr. Pullin, of Woolwich, exhibited some illustrations to indicate the value of X-ray examination, as applied at Woolwich. Discussing a method of inspection by means of radium, he exhibited an X-ray photograph and a radium radiograph of a specimen. The X-ray photograph showed a flaw quite distinctly; in the radiograph there was also an indication of the flaw, but not so definite; but when radium was used there was a penetration of the thick portion of the metal, which was not attained with X-rays.

Dr. Rosenhain, in a brief reply to the discussion, said he had deliberately put forward questions with regard to which he knew there were considerable differences of opinion. He thought that, perhaps, the whole point had been confused during the discussion by mixing up foundry technique and inspection with the question of testing. The only speaker with whom he cordially disagreed was Mr. Hignett, who seemed to have misconceived the whole question at issue. When Mr. Hignett suggested that the founder should be allowed to adjust his test bar so as to get the best results out of the metal, he was suggesting that we should allow a man who made inferior metal to get sufficiently good tests out of it by any device he could use. That was how the suggestion would be interpreted in practice. We must standardise things; if A could make metal with that standard material, B could do it also, or he was at fault, provided that the standardisation was arrived at as a result of sufficiently careful investigation.

He did not think Mr. Genders' criticism of the suggested use of the bend test was justified, because although there was something in the fact that the elastic deformation of a light alloy beam would be greater than that of a cast iron beam, yet he believed that the permanent deflection would still be very much easier to measure than the small extension on a tensile test piece. One thing which had arisen out of Mr. Genders' remarks, and which probably it would be possible to incorporate when it came to carrying out the test after further investigation, was to test, not by the application of a single load, but by the application of such loads as would give a uniform bending moment over the part of the beam under test, and in that way obtain the elongation—the deflection really—over the greater length of the test piece than would be the case if a single bend were applied. It meant merely a double ram on the bending press instead of a single one, and he believed that that would overcome the difficulty, if, in fact, it proved to be as serious as Mr. Genders had suggested.

(To be continued.)

Institution of Naval Architects.

No. II*.

IN what follows we continue our account of the Spring Meetings of the Seventy-third Session of the Institution of Naval Architects, which took place at the Royal Society of Arts from Wednesday until Friday of last week. After the President's address, which was recorded on page 316 of our last issue, the reading and discussion of technical papers was begun. The first paper presented on Wednesday morning, March 16th, was one on "Electric Arc Welding in Ship Construction," by Mr. J. Forster King and Dr. James Montgomerie, a short summary of which is printed below.

ELECTRIC WELDING FOR SHIPS.

In this paper the progress made during the last fifteen years in electric welding applied to shipbuilding is reviewed, and the attitude of the classification societies towards this new method of construction is defined, the leading ideas which have governed the framing of recent welding regulations being discussed. Although, the authors remark, cost may have kept back progress in this country, recent welding work done in America and Germany has directed renewed attention to the subject. Reference is made to electrically welded barges lately built in Germany, and to two large vessels now being constructed for the Hamburg-Amerika Line in which electric welding is being extensively employed. The progress made since 1918 and the advance made in the manufacture of electrodes with increasingly satisfactory results with regard to strength of weld is touched upon, and the experience gained with the electrically welded vessel "Fullagar"—now named the "Shean"—is dealt with in a very complete statement.

Commenting on the possible corrosion which might occur in the weld metal and the metal in the neighbourhood of the weld, the authors state that while, on a rough surface corrosion may take place, in other circumstances the degree of corrosion found does not differ appreciably from that found in the surrounding metal. All that has been learned during the past fifteen years, they go on to say, leads to the conclusion that the efficiency of the weld depends upon the welder, the ductility and the quality of the deposited metal, the design of the work, and the method of doing the work. The progress made in the manufacture of electrodes is illustrated by a statement to the effect that an Izod impact test value of 35 foot-pounds is now obtained for a modern electrode compared with a corresponding figure of only 10 lb. for earlier types of electrodes. With regard to the supply of welding operators having the necessary practical and technical knowledge, the authors express doubt as to whether there will ever be a sufficient supply of highly skilled operators, and they regard it as desirable to devise methods whereby ordinary operators working under shipyard conditions will be able to produce a sound job. They are further of the opinion that the supply of operators with the necessary degree of skill is short of present requirements, not to speak of the day when shipbuilding will revive and when welding on a large scale may possibly be employed.

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The methods by which a sound welding technique can be built up are then discussed, especially in their relation to the particular jobs met with in shipbuilding practice. Finally, emphasis is laid on the necessity of inspection, which the authors regard as the first, the last, and the most important factor in the success or failure of electric welding. The welding process in the shipyard, the authors point out, is continuous, and a great responsibility is therefore thrown on the management of the shipyard if rigid inspection is to be maintained. The final conclusion reached is that electric arc welding has now reached a stage of development which, both with respect to the composition of the electrodes and existing knowledge of the methods which will ensure good work, enables conditions to be specified which will permit of its use in the more important parts of the structure of a ship.

Sir James Lithgow, in a written contribution, said that the authors' repeated references to the need for highly skilled operators in welding work were, in his opinion, not merely liable to be misconstrued, but to give an entirely wrong impression of the nature and degree of skill which was necessary for an electric welder operating on the quality of steel used in shipbuilding. The commercial development of welding on shipbuilding work necessitated the development of methods whereby operators of ordinary skill, working under ordinary shipyard conditions, would be able to produce reliable work. It would be a thousand pities if the impression left by men of such eminence as the authors was that there was anything mysterious in electric welding, calling for special training or knowledge which the British workman did not have or did not readily acquire. His own experience convinced him that within a very few years we should have no difficulty in providing plenty of competent welders for shipyard work. Given suitable methods and materials, proper design, and the requisite direction and supervision in the yards, there should be no difficulty whatever in training welders to keep pace with the development of electric welding on shipbuilding work.

Mr. J. T. Batey, commenting on the authors' statement that the difficulties inherent in the electric arc welding process had not encouraged shipbuilders to embark upon its extended use, said that many shipbuilders had been quietly and steadily experimenting, gaining knowledge, and training certain of their men so that when the time came—and it was coming very shortly—there might be intelligent workmen who could carry out electric welding to meet the classification societies' requirements, whom he asked to encourage rather than discourage the people who were endeavouring to bring that process to perfection. Any rules they made should be elastic. There was no need to have certificated skilled workmen. In Messrs. Hawthorn, Leslie's yard a large amount of electric welding had been done on His Majesty's vessels recently, and it was interesting to see the workmen taking a great interest in it and turning out excellent work.

Mr. A. T. Wall said, with regard to the "Fullagar," that she had been a technical success. The grounding damage she had sustained was very severe indeed, and, being a single-bottom ship, she would certainly have been flooded practically all fore and aft had she been riveted; in fact, however, she had made no water at all. It was not correct to say that the welding was all done by experienced operators; only one man was an experienced welder, and he had trained the other men. The training had not occupied years, but only months, and sometimes weeks. There seemed to be a tendency in the paper to exaggerate the difficulties. Whilst he agreed that welders must have some training, and that it might be a specialised training, he did not see why it should be tackled as though it were some extraordinarily difficult, obscure, and mysterious affair. He was not sure that welding would come into general or complete use until its application was removed from the realm of the shipyards using rivets. It was such a different process as to call for entirely new methods in design, drawing-office work, methods of assembly and erection, lay-out of the yard, and use of the various tradesmen. Perhaps it would be best to establish one or more shipyards for the exclusive construction of welded vessels, manned by progressive men with admitted experience of building ships, all bent on welded construction, and, indeed, with no facilities for riveting. Only five days ago Mr. N. M. Hunter, manager of the Wallsend shipyard of Swan, Hunter, Ltd., had said it seemed to him that we were on the eve of what might turn out to be a revolution in ship construction by the development of electric welding, and that, in fact, some builders were prepared to quote an alternative and cheaper price for a ship built by that method. Further, said Mr. Wall, a structure could be produced, not only stronger, but from 12 to 20 per cent. lighter.

Mr. Norman Hunter said that the authors likened deposited metal to cast steel which had not been subjected to heat treatment, but he thought some allowance should be made in the case of heavily coated electrodes, for the retarding of the cooling and also the annealing effect of the depositing of subsequent runs of weld metal where more than one run was used. It was admitted that the grain structure of the steel close to the weld was more or less damaged, but in ordinary shipbuilding that also happened with punching, joggling, flanging, &c. Hence he did not consider the slight derangement caused by welding to be a serious objection to its use. The "Fullagar" was a very wonderful ship. When she grounded the bottom was pushed up about 11in. over a considerable area, and was repaired simply by pushing it out again with jacks, no leakage from or cracking of electric welding being found. That, he thought, spoke volumes for the strength and efficiency of the welding. The welder must not be confused with the welding engineer. Like the riveter, his sphere was practical production in accordance with the instructions given to him, not theoretical speculation. No necessity existed for training schools and certificates for shipyard operatives, who could be taught their job in the works in six months.

Sir Westcott Abell did not think the welder need be quite as expert as the paper seemed to suggest. Once the man was instructed, the job became more or less a matter of repetition. With regard to the authors' suggestion that more ductility was required in the welded material, Sir Westcott said he thought they were right, but how much more was required he did not know. The point that interested him was that although the "Fullagar" was very severely damaged, and although the ductility at the joints was low, there had been no trouble in the joints so far as could be observed.

Mr. John G. Brown said that in his experience it took about two years to train a good overhead welder.

Major Caldwell, who has specialised during the last fifteen years in the application of electric welding to steel construction, said he interpreted the paper as indicating the adoption by the authors of a favourable attitude towards electric welded construction. Whilst he appreciated what had been done in the past by our classification societies in preventing the indiscriminate substitution of welding for riveting, surely the time had arrived for shipbuilders to go forward with a constructive policy, in view of the knowledge which had already been published, quite apart from the individual or private experience gained by certain firms in this country within recent years. He congratulated the authors of the paper on the emphasis which he understood they had placed on the fact that consistent reliability was required in a welded structure; indeed, that was the crux of the whole matter, and it was the more important in these competitive days—he was told that there were forty-five manufacturers of electric welding products in this country alone. It had been stated in the paper that the reason for its presentation was the known activity in Germany and America. That statement might be interpreted by the public to mean that we in this country were followers rather than leaders, whereas the reverse was the case in that particular branch of engineering and shipbuilding; but the pity of it was that welding engineers and manufacturers had recently obtained most of their practice and experience in their own particular methods outside this country. Corroborating the statements by previous speakers to the effect that welders need not be very highly skilled, he said that of the five men employed in the welding of a British cross-Channel barge of 225 tons displacement, the best was an assistant grocer from Cardiff, the next an electrician's mate from Belfast, the third a boilermaker, and the other two good soldiers. Finally, commenting on the advice given by Mr. Foster King, that shipbuilders should learn something from bridge builders, he said that some thirty-six bridges—foot bridges, road bridges, and railway bridges—had already been constructed by means of electric arc welding.

Mr. Bart S. Varty (Ingenieur du Bureau Veritas) said that the paper showed that electric welding for hull work might be considered as a commercial proposition, advancing beyond the experimental stage, and that "sound, strong, and reliable" connections could be obtained in practice. It showed also that that result could only be secured if one could rely on the absolute and impeccable professional conscience on the part of the operators. Concerning those two points, the classification societies which were called upon whenever a new method was introduced into shipbuilding had an important part to play. They must use their moral influence to obtain the best methods of workmanship, and also in the application of the rules with a care not required by older methods. The classification societies must also give certain instructions, if not in a definite and complete manner, at least with a certain and sufficient precision in order to guide the operators. It might have been of interest if the authors had added to their valuable paper some information regarding the rules which they had published or which were actually under preparation. The Bureau Veritas had introduced a special chapter on the question into the Rules for Inland Navigation Vessels—at present in the press—and the Germanischer Lloyd had just published rules on this subject. New Rules could only be provisional, as progress was being made rapidly, and, moreover, the builders must keep on the safe side in order to avoid unforeseen difficulties. He was of the opinion that they were on the eve of most important developments in the utilisation of oil for industrial purposes. That would lead to increased consumption and increased means for transport. A rapid increase in the utilisation of electric welding should follow as a natural course, and builders and classification societies must work together in order to obtain a satisfactory result for all parties concerned.

Dr. Montgomerie, replying to the discussion, said that all classification societies attached a great deal of importance to the ductility of the parts which were to be joined, and naturally experience had shown that when one employed a riveted joint one had something which approximated to the elastic quality of the materials to be joined. It could suffer change of shape without losing any or all of its elastic properties. That being so, it was surely the duty of engineers—not to speak of classification society officers—to see that when a substitute was proposed the ductile qualities of that substitute should be investigated. The investigations of reputable electrode makers had been devoted during the past ten years to the production of an electrode which would deposit a material approximating to the material to be joined. The authors still required the standard they had required ten years ago, the difference being that they were now getting it. There seemed to be some misconception with regard to the statements made in the paper concerning the training of welders. The authors did not suggest that the art of electric welding should be elevated into some esoteric mystery, with its trade union high priests and acolytes, and so on; but they did claim that welders should be trained, and that they could not be trained in a fortnight. In America special classes, not only for welding operators, but for engineering supervisors, had been instituted, and in Germany very efficient systems of training welders and supervisors were in operation. Mr. Foster King and he had merely stated that welders should be trained, and by the builders. They did not say that even the classification societies should issue certificates. In reply to Mr. Batey, he said the rules so far published by classification societies had not been detailed rules; it would not be possible to make such rules, and there was no desire on the part of the classification societies to interfere with the free development of the system. Mr. Batey wanted to train operators on parts which were of secondary importance, but he would find some difficulty in carrying that out. The economic pressure on the builder would be to use it, not so much on the lighter parts of the structure as on the heavier parts.

A paper by Messrs. W. J. Lovett and E. H. Smith, of which we give a summary below, was then presented.

COMPARISON OF A MAIER AND A NORMAL FORM.

This paper deals with a comparative investigation, including tank experiments and results, which was undertaken by Workman, Clark (1928), Ltd., in order to determine the characteristics of the Maier form of hull in relation to those of a normal design, for a single-screw ship of the following dimensions:—Length between perpendiculars, 420ft.; breadth, 60ft.; depth moulded 41ft.; displacement, 14,200 tons; speed at loaded draught, about 12½ knots. The models tested at the Teddington Tank included a Maier form model, the firm's form model, and a tank form model, which were tested at speeds from 10 up to 14 knots. In the paper the results of the tank experiments are given, together with the hydrostatic characteristics.

The results, it is stated, are not regarded as being entirely conclusive, but the investigation, it is emphasised, has been undertaken impartially. The records suggest that the claims made on behalf of the Maier form, that its adoption results in a decrease of power required, at least for a vessel of the type chosen as the example, are far from being substantiated. It is further emphasised that the deductions made refer only to one particular vessel of definite proportions determined by service considerations. Variations in different directions might yield different results.

Another claim made for the Maier form is its better seaworthiness. Under the circumstances, it has only been possible to investigate certain of the characteristics embraced within this heading. An interesting feature is the manner in which the percentage variation between the different normal forms and the Maier form fluctuates. This characteristic has not been observed in any other published comparisons between normal and Maier forms. Depending upon the respective trial and service speeds, and their incidence in relation to the crests and hollows of these curves, it is suggested that this may explain why an apparent gain with the Maier form in certain circumstances appears greater in service than on trial.

The Maier form company probably claims that its design gives the shortest possible path for the water streams, and results in a full load-line and easy bow lines and buttocks, which are undoubtedly good for low and reasonable speeds, but the same characteristics can be and are adopted in the normal form with at least equally good results, and it will be noted elsewhere in the paper that the wetted surfaces in both cases are practically of equal area.

As a final note, it may be said that, given an initially bad form, it is, of course, quite easy for either the Maier or the Tank authorities to improve upon that form.

Dr. G. Kempf said that a large number of Maier form models had been tested in the Hamburg Tank, and that they had proved, as an average, superior to their normal sister models.

The point made by the authors, that the moment to change trim would have quite an appreciable effect on the pitching of the vessel at sea in favour of the Maier form, was the most important consideration in regard to it. Seaworthiness seemed to be one of the most important properties of the form, from his own experience in tank work and the experience of all whom he could find who had travelled in Maier form vessels. Moreover, he had tried to get some exact measurements on three models with different bow forms—Maier form, normal form, and bulbous form. The trim movements of three different ship forms heading against the same waves were compared. The Maier form had the least pitching at the stern; the centre of movement was shifted to the stern. The full results, however, had not yet been published.

Mr. F. Marley Hay said it was greatly to be regretted that the paper was written in its present incomplete

and inconclusive form. His objections were two-fold. First, that the results of any single isolated case, whether favourable or unfavourable, formed no criterion of what might or might not be achieved with Maier form lines in general, and, therefore, the conclusions drawn might be misleading; secondly, that the programme of tests had not been completed as agreed upon, and, therefore, the results of even that single isolated case would be only partial and entirely inconclusive.

Leaving aside considerations of impartiality or otherwise, Mr. Marley Hay commented on some of the points in the paper. Reference was made in it to "the range of trial speed of 13½ to 14 knots." On another page two other speeds were mentioned, viz., 12½ and 11¼ knots. The original inquiry sent to the Maier form company mentioned only one speed—"speed on trial, 13 knots." To improve on his design at a speed of 13 knots was the specific problem set. The Maier form company also knew from the prospective owners that 11,000 tons displacement was the displacement to which most importance was attached. On the author's own showing, at that speed, the Maier design at full draught required 81 E.H.P. less, and at light draught 129 E.H.P. less than the firm's design. At both draughts the Maier E.H.P. for the preliminary design was even less than that required for the Teddington design with which the opportunity to make any comparative test had been denied. From those facts the author had drawn the remarkable conclusion in his summary that the claim that less power was required for the Maier form was far from being substantiated.

The anticipated difficulties of docking a Maier form ship due to the overhang forward had not yet been discovered by the owners of any of the thirty vessels now in service, or, if so, the discovery had been kept a secret, and they had even permitted the execution of many repeat orders without that secret being divulged.

Mr. G. S. Baker (National Physical Laboratory, Teddington) said that that was the first paper before the Institution showing a definite comparison between a normal and Maier form ship, and the Institution was greatly indebted to Mr. Lovett and Mr. Smith, and to their firm, Messrs. Workman Clark, for carrying out the tests at its own expense and publishing the results. The results given by the authors showed that the normal form was always as good as the other.

Mr. Baker exhibited a drawing showing sets of lines for a normal ship, very similar to the one on which the paper was written, and an alternative very similar to the Maier ship form. Three lines were shown on the drawing to represent the three draughts at which the tests were made, and the corresponding beam and draught ratios were given. In the deep condition the Maier form had a much broader water line, in the medium condition there was not very much difference, and in the light condition it was distinctly shorter and of a different character. There was a condition when the Maier form gave a very good combination, some 2 per cent. better than a normal hull; but it lost that advantage as draught changed either way. It was thought that the marked downward flow would affect the screw, and a new screw was tried in the light condition, as stated in the paper. As the improvement was not as much as was expected, it had since been tried in the deep condition, and the propulsive coefficient obtained with the Maier form with the new screw was practically the same as on the normal form. In other words, somewhat more care than usual was required in designing the screw with Maier forms.

Last year, continued Mr. Baker, Mr. Hay had paraded a number of results obtained in a number of tanks, to induce naval architects to believe that the Teddington Tank was the only one which had failed. The results now given, however, showed that it had not failed, and that the experimenters there had succeeded in producing a form as good as the Maier. He was quite willing to believe that the Maier form Corporation's ships were seaworthy, but he asked those concerned with ships to believe that the ship designs at Teddington were also seaworthy.

Mr. E. Van Dieren (Superintendent Naval Architect, Royal Netherlands S.S. Company) said that "normal" was no definition; it could be anything, even a thing which other people thought abnormal. Except that it was a patent, there was much to be said in favour of the Maier idea. First, from the frictional resistance point of view. He referred to some experiments carried out in the Berlin Tank with a Maier model of a 300ft. cargo ship of 0·76 block coefficient, which experiments had proved that Maier forms could be drawn with the water running along the shortest paths; further, for a Maier form, those shortest paths were the shortest possible. Secondly, from the residuary resistance point of view, there was something to be said for Maier's ideas, and in that connection he referred to the work of Dr. Georg Weimblum, published in a paper on "Ship's Form and Wave Resistance" in November, 1931.

Mr. A. T. Wall said there had been a good deal of recrimination outside the Institution on account of the publication of the paper, and he could not understand why the paper was presented at that stage.

Mr. H. G. Williams said that, as the authors had pointed out, the results of the experiments as between the forms tried were not entirely conclusive. The differences in propelling power required were too small and irregular at different speeds and displacements to show that one design was definitely superior to the other. That was especially the case when one considered the margin of uncertainty in correlating the model and full-size results, owing to the effect of form on friction correction. The lack of scientific interest in the paper arose from the incomplete information given as to the forms compared.

Mr. John Anderson associated himself with the remarks of Mr. Baker that the authors had done the Institution a service in placing their results before it.

Dr. E. V. Telfer said it was extremely unfortunate that the Maier form Company was not afforded an opportunity to consider the final Teddington model, and thus truly represent the respective responses in ship form improvement over a basis supplied by a shipbuilder lacking model experimental facilities. That fact, together with the general search for disadvantages of the Maier form evident throughout the paper, hardly convinced the reader of the impartiality of treatment which the authors claimed in their summary. True impartiality would admit the Maier victory at the 11,000 tons displacement and bring all normal form experience to bear upon the repetition of that success at the deeper draught. The fault of the Maier form there was fairly obvious, and appeared to be a special case of the experiments reported upon by Mr. Baker in the Institution's 1913 "Transactions," dealing with the influence of the ratio of length of entrance to length of run.

In fairness to the Maier form Company, he trusted that an opportunity would be accorded it to include in the discussion on the paper the results of the tests on its best model. The issue involved was not one of mere designing skill, but of principle. If that principle could be established, a concrete advance in the subject of ship resistance would have been achieved.

Mr. Smith intimated that, in view of the detailed nature of the discussion, the authors' reply would be submitted in writing. In order to clear them of any suggestion of unfairness, however, he pointed out that the intention to present those results to the Institution was conveyed to all interested parties, including the Maier form Company, before the tests had been carried out at Teddington. The results might not be conclusive, but they were presented only from the shipbuilders' point of view. He apologised with regard to the procedure. Unfortunately, the authors had committed Mr. Baker in advance to supplying the Maier form Company with the body-plan.

In conclusion, he said that no shipyard in this country could feel that it was in a happy position when, no matter how it struggled and strove to achieve its best in its endeavour to satisfy its clients, it was always confronted with the challenge that might come from a company which possessed the monopoly of a patented article, that it would do 10 per cent. better. The work was done in an inquiring spirit, and because it was thought that the information would be valuable, would throw further light on the problem, and would give definite evidence as to the superiority of the Maier form, which even to-day was not forthcoming, in the authors' opinion.

Mr. Neeff (a director of the Maier form Company) said the paper clearly indicated that the fundamental principles involved in the endeavour to produce forms of lower resistance than normal forms had not been thoroughly understood. The Maier form Company did not claim to produce, *ab initio*, a form to fulfil a given set of conditions, which would have the minimum of resistance; but it did claim that, given the best normal form for any condition, it could frequently so alter the lines, especially of the fore body, that the modified form would have a lower resistance, and that whatever improvement was obtained in still water was considerably increased at sea.

(To be continued.)

Floods in the Thames and Wey Valleys.

By E. S. BELLASIS, M. Inst. C.E.

THE river Wey—see sketch map—has a catchment area of 338 square miles. Above Godalming it is in hilly country. The remaining 28 miles to Weybridge, where it joins the Thames, are canalised and embanked where fairly straight, the canal at other places being cut across a loop of the river. Near the commencement of each loop there is a weir with sluices. The width of the river is generally about 40ft. The weirs are, on the average, only 2·2 miles apart. In a flood the sluices are drawn gradually.

From Godalming to Walsham—20 miles—there are flat lands subject to flooding; the area flooded in an ordinary flood is estimated at about 1200 acres Recorded floods at Guildford are given in the table; the discharges are mostly estimates; from Godalming to Guildford is 6 miles.

A scheme for reducing flooding, which has been accepted, and frequently discussed in the local Press, is to increase the discharging capacity of the river below Godalming by cutting out some of the numerous bends, widening, or, perhaps, deepening, the channel at some places and increasing the capacities of the weirs when the sluices are fully drawn. The flood level will be lowered at all points, perhaps, by half-a-foot or a foot. The scheme is not intended to cope with extraordinary floods, but to give substantial relief in ordinary floods. The overflows are numerous, and the land not far from the river or a tributary of it; the flooding, therefore, proceeds rapidly, is checked by the rise of the flood water on the fields and ceases when the rise of the river is completed, except for a small discharge estimated—from some Indian and other figures,* with due allowance for the English conditions, including recently fallen rain—at 1 cubic foot per second for 10 acres, to replace the water lost by percolation. This discharge ceases when the river falls; the floods disappear in a few days.

Number.	Year.	Maximum discharge.	Nature of flood.
		C. ft. per second.	
1	Feb., 1900	2400	Extraordinary (5ft. over bank)
2	Jan., 1928	1900	Ditto (3ft. over bank)
3	Nov., 1929	1000	Ordinary
4	Dec., 1929	1145	Ditto (·5ft. over bank)
5	Jan., 1932	1125	Ditto (·4ft. over bank)

On the evening of January 11th, 1932, the discharge at Guildford—observed—was 1100 cubic feet per second. The flood was at its peak, and the flooding above Guildford—about 250 acres—had been completed earlier. The discharge in the absence of any flooding would have been 1125 cubic feet per second. The flooding delayed the arrival of the full flood at Guildford by about 3·3 hours, that being the time required for the mean discharge of the river—say, 900 cubic feet per second—when above the low-water stage to flood 250 acres to a depth of 1ft., which is about the average depth. At Walsham, on the night of January 12th, the peak discharge was about 1300 cubic feet per second, including 95 cubic feet per second for percolation below Guildford. The arrival of the flood at Walsham was delayed by about 10·1 hours from Guildford, or 13·4 hours from Godalming. At Weybridge the delay would be the same.

CATCHMENT AREA OF RIVER WEY

Assuming that the improvements stop three-fourths of the ordinary flooding, the delay in the peak of the flood at Weybridge will be 3·35 instead of 13·4 hours. It will reach Weybridge ten hours earlier. But its fall depends on the reduction of the Wey discharge at Godalming and from the tributaries, and this will not be affected. The peak of the flood will remain at Weybridge ten hours longer than now; that is, for about twenty-two hours. Its discharge will be increased by 90 cubic feet per second. The smoother and steeper channel will cause the velocity to increase by, perhaps, 6 per cent. The flood will commence at Weybridge some two hours sooner and end two hours sooner.

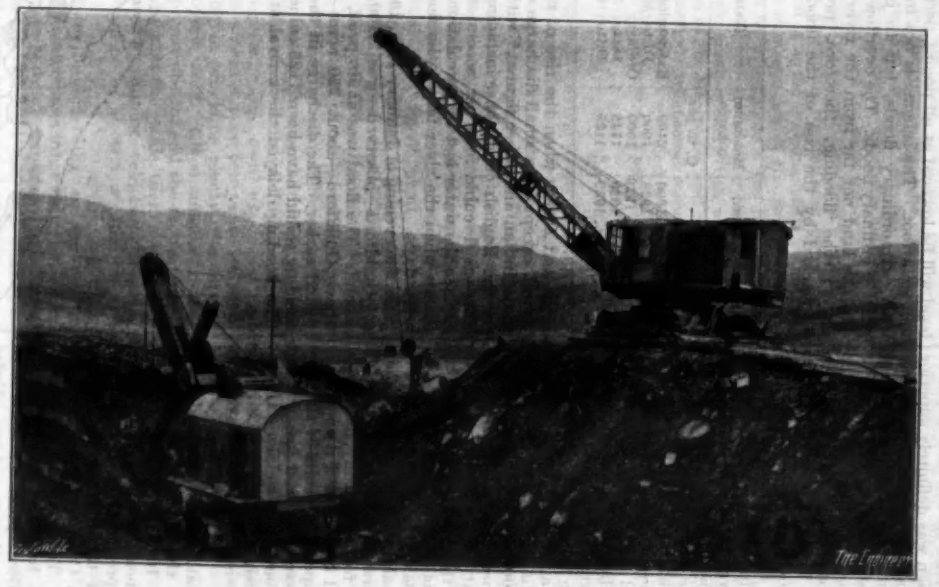
It has been asserted that the Wey improvements will increase the Thames floods. The Wey floods occur in winter when an ordinary Wey flood gives, say, 1100 cubic feet per second more than the low-water discharge. Trouble occurs only when such a flood coincides at Weybridge with a very high Thames flood, which is about 17,000 cubic feet per second; one of 7000 cubic feet per second is a low one. During floods Nos. 1 and 2, the head and tail waters at the Guildford weir were nearly equal. The improvements would have had no appreciable effect on the area flooded, or on the discharge into the Thames. Both the floods were due largely to melting snow, but there was also heavy rain. Rain has great effect in causing snow to melt.

In the cases of floods Nos. 1 to 4, the rainfall in the Wey basin always covered the same period as that in the Thames basin, and its ups and downs largely corresponded. The peaks of the Wey floods reached Weybridge before those of the Thames floods by about two, three, four and four days respectively. In 1932 the rainfall periods again coincided,

* E. S. Bellasis, "River and Canal Engineering," Cap. VI., Art. 2, London, 1931.

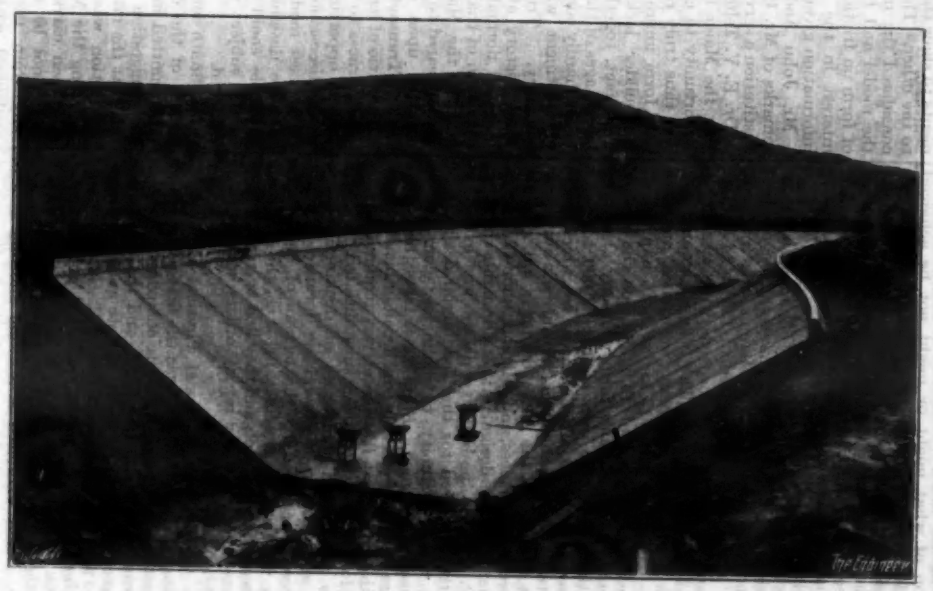
EXCAVATION WORK ON THE TUMMEL DEVELOPMENT, GRAMPIAN POWER SCHEME

(For description see opposite page.)



RANSOMES & RAPIER SHOVEL AND DRAGLINE EXCAVATORS AT WORK IN THE AQUEDUCT

AQUEDUCT TRIMMED READY FOR CONCRETING



CONCRETE LINING OF AQUEDUCT

but in the earlier days the Cirencester area got more rain than the Godalming area, these conditions being reversed in the later days. This time the peak of the Thames flood arrived first at Weybridge by about one day. The Wey flood arrived when the Thames flood was beginning to fall and prolonged it. The arrival of a tributary flood before that of the main stream is common. The tributary is shorter. The Wey flood arrives first at Weybridge four times out of five. A very high Thames flood comes about once every ten years, and it usually remains very high for about three days. The Wey flood should arrive after it once in fifty years—and it probably does not escape meeting it—but, as the Wey statistics are meagre, once in thirty or forty years may be accepted. This meeting of the floods—the Thames flood being 17,000 cubic feet per second—gives a rise in the Thames of about 6in.

In floods Nos. 3 to 5, the 90 cubic feet per second would have raised the Thames level by about ¼in.—or, say, ⅓in., to allow for possible errors in the flooded area, &c.—and the flood would have come some 2+10=12 hours earlier and have ended two hours earlier. For the reason just given the ten hours may be extended to fifteen. In any case, the acceleration would have made more certain the meeting of the floods in 1932 and have also prolonged the flood. This and ¼in. or ⅓in. rise is all the harm that can be caused on the Thames by the Wey improvements. Harm is quite as probable—and it will be greater and independent of the improvements—in the case of extraordinary Wey floods, like Nos. 1 and 2, which are likely to recur now and then with very high Thames floods.

Excavation Work on the Tummel Development.

THE Tummel development, an extension of the Grampian Electric Supply Company's undertaking in the Perthshire Highlands, provided the contractors with an interesting excavating problem. According to this scheme, an aqueduct about 3 miles in length has to be cut along a hillside above the river Tummel through ground of a very difficult nature from the point of view of mechanical excavation. The nature of the ground and to a certain extent the limited accessibility of the site, necessitated the adoption of a somewhat unusual method of carrying out the work. When all the factors concerned are taken into account, it will be admitted that the work performed has demonstrated fully the wonderful capabilities of modern mechanical excavators for dealing with material of a very difficult character.

Since the aqueduct is being cut on a hillside, the material excavated out of the higher ground can be utilised to form the necessary embankment on the other side. Normally, where the material is sufficiently uniform, it is usual to excavate such a section as that illustrated in Fig. 2 by the use of a dragline excavator. The machine is chosen to have a dumping radius sufficiently great to reach approximately from the centre line of the aqueduct to a point well down towards the toe of the embankment. In this way by moving the excavator forward along the centre line of the aqueduct the embankment can be built up without double handling the material.. An inspection of the site, however, before work was begun demonstrated clearly that dragline working would be quite impracticable. The material to be removed consisted of a mixture of clay and gravel, and there were embedded in it a very large number of irregularly shaped boulders. The work obviously called for a shovel type excavator, which, by tackling the material from below, could undermine and so loosen the boulders. Since a shovel has necessarily a smaller dumping radius than a machine of similar size equipped as a dragline excavator, the problem as to how the embankment was to be built up had to be faced. The use of a shovel sufficiently large to render double-handling of the material unnecessary was a possible solution, but unfortunately two factors precluded the use of such a machine. The section of the aqueduct was too small and the depth of material insufficient.

Consequently, the possibilities provided by a combination of shovel and drag line excavators were examined, and in spite of the disadvantage brought about by the necessity to double-handle the material, several compensating advantages were revealed. It was found that if, in conjunction with the shovel working on the centre line of the section, a dragline excavator moved along the top of the embankment, only part of the material would have to be double-handled. At the same time the possibility of sorting some of the material, which, considering its nature, was obviously necessary, became an advantage rather than a hindrance. The dragline excavator besides building up that part of the embankment which the shovel could not reach, would also be capable of sloping the embankment and generally cleaning up the section in the path of the shovel, while its weight acting upon the recently placed material would help considerably the consolidation necessary before concreting could be begun.

In view of the advantages accruing, this method of working was therefore adopted when work upon the aqueduct was begun in June last year. Since that date rather more than 1½ miles of the excavation has been completed, a satisfactory rate of working.

The range of the shovel excavator when operating in the maximum cross section and the dumping reach obtainable in relation to the whole embankment, are indicated in Fig. 1. That portion of the embankment which can be built without double-handling of any of the material is also shown. Some idea of the conditions under which the machines had to work and the material that had to be moved can be gained from the photograph reproduced in Fig. 3. The size of the boulders can be judged by comparison with the dimensions of the excavators. In some parts very few of the boulders encountered were smaller than the bucket of the shovel! Stages of the work, demonstrating clearly the success with which the two machines combined, are to be seen on the opposite page. They show the excavators in operation in two parts of the cut, the section trimmed ready for concreting and the aqueduct concreted and almost completed.

The machines employed on the work were constructed by Ransomes and Rapier, Ltd., of Ipswich, and it is claimed that they are the largest machines used for this type of work in recent years. The shovel, which normally carries a 2–2½ cubic yard bucket, is for the work in hand fitted with high-lift equipment, for which the bucket has a capacity of 1½ cubic yards. The dragline is standard in all respects. It has a 45ft. boom and a 1½ cubic yard bucket. Owing to the difficulty of maintaining coal and water supplies, particularly in winter time, the decision was taken to use electrically driven machines. Before that decision was reached, however, a very full investigation was made of the capability of such equipment to stand up to the onerous digging conditions it was likely to meet. To meet these conditions the makers of the machines have standardised an electrical equipment by which, instead of taking current straight from the line to A.C. motors, operating the various motions of the excavator, the current—in the case under consideration 440 volts, three-phase, 50 cycles—is led to the terminals of an induction motor driving a D.C. generator. The converter set is mounted on the excavator and the generator is arranged to have a drooping voltage characteristic. By this means the separate D.C. motors operating the various motions of the machines are given a flexibility comparable with that of the steam engine, speeding up under light load and slowing down when the load is excessive. The maximum torque is definitely limited, the motors can be stalled without suffering any damage, and the torque is applied gradually, irrespective of the skill of the operator and without the use of automatic relays. The makers state that as much as 30 or 40 per cent. of the power consumed by a shovel equipped with A.C. motors is saved by converting to D.C., while at the same time much of the shock and wear and tear is eliminated. Power is fed to the machines by means of flexible cables of the four-core conductor type, the fourth conductor being an earth wire.

The work on the Tummel development is being carried out by Balfour, Beatty and Co., Ltd., the engineers and contractors to the Grampian Electricity Supply Company.

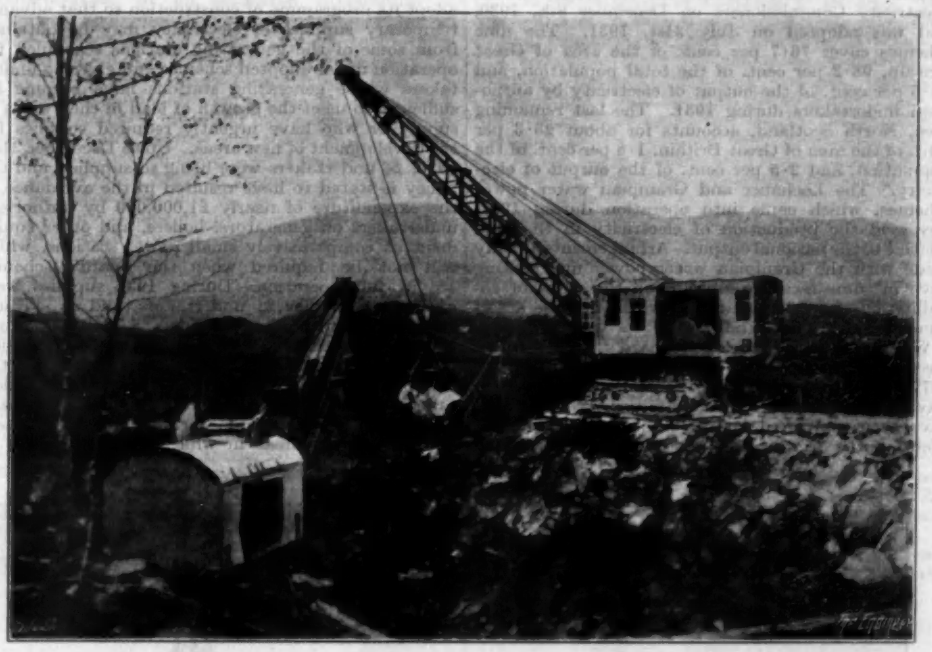
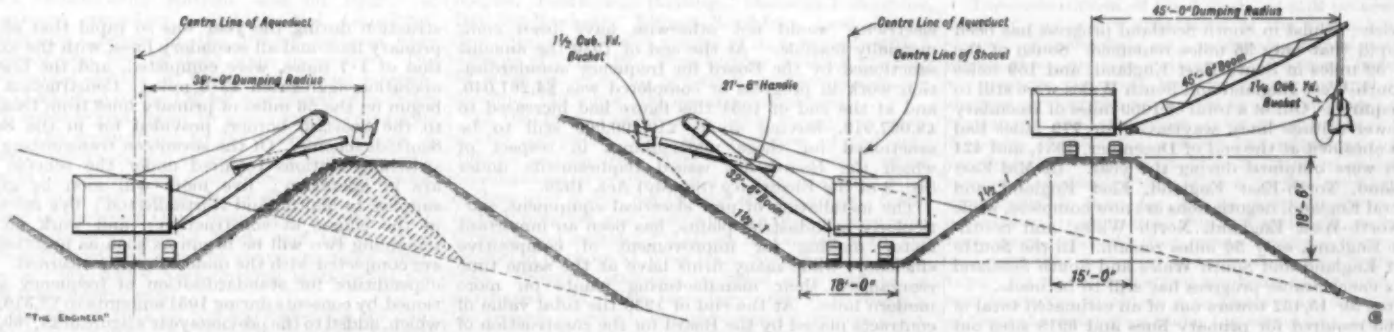


FIG. 3—EXCAVATORS AT WORK ON DIFFICULT GROUND



FIGS. 1 AND 2—DUMPING REACH OF SHOVEL AND ARRANGEMENT OF EXCAVATORS IN THE SECTION

NEW GOLD-BEARING AREAS.

VAST gold-bearing areas are still to be opened up on the extensions of the Witwatersrand goldfield. When reviewing the results obtained on the extension of the Far East Rand during the past few years, one cannot but be impressed with the opening up of one new mine after another in areas which not many years ago were considered either worthless or too big a gamble to be worth investigation. Welgedacht, Grootvlei, Palmietkuil, Rietfontein, Vogelstruisbult, and Vlakfontein are only a few of many farms which may yet produce a dividend-paying mine in the areas which hold considerable promise. It is only by the gradual expansion of the workings of the neighbouring mines that these areas can hope to be proved. Another important area which holds out just as bright prospects is that lying to the south and in the vicinity of the Sub-Nigel Mine. It can safely be said that this area of the Rand is in its infancy, and there is no knowing what may yet be discovered in the deeper levels of the large area of ground which extends both north and south of these Sub-Nigel workings. Here again it is a question of gradual expansion, which will take many years to complete, but the possibilities are so great that a new era may dawn on the Rand and huge gold producers may come into being on ground which to-day is used wholly for farming.

THE official returns rendered to the Electricity Commissioners show that 1133 million units of electricity were generated by authorised undertakers in Great Britain during the month of February, 1932, as compared with the revised figure of 1006 million units in the corresponding month of 1931, or an increase of 12·6 per cent. During the first two months of 1932 up to the end of February the total amount of electricity generated by authorised undertakers was 2295 million units, as compared with the revised figure of 2155 million units for the corresponding period of 1931, representing an increase of 6·5 per cent.

The Central Electricity Board's Fourth Annual Report.

COVERING the year January 1st to December 31st, 1931, the Central Electricity Board's fourth annual report deals, as usual, with the progress of the "grid." At the beginning of 1931 schemes for eight areas had been adopted by the Board, leaving only South and North Scotland to complete the national system. The former scheme was received from the Electricity Commissioners on December 8th, 1930, and was adopted on July 31st, 1931. The nine schemes cover 76·7 per cent. of the area of Great Britain, 98·2 per cent. of the total population, and 97·5 per cent. of the output of electricity by authorised undertakers during 1931. The last remaining area, North Scotland, accounts for about 23·3 per cent. of the area of Great Britain, 1·8 per cent. of the population, and 2·5 per cent. of the output of electricity. The Lochaber and Grampian water power schemes, which came into operation during 1931, increased the production of electricity in the area relative to the national output. Arrangements already made with the Grampian water power undertaking have in some measure anticipated the work of co-ordination and interconnection which may be determined for North Scotland.

Wayleaves acquired for the Board's 132-kV transmission lines gave at the end of 1931 an aggregate of 2677 miles. During the year 1286 miles were acquired, leaving only 225 miles to be obtained. Negotiations have been completed for the whole of England and Wales north of the line Worcester, Bedford, and Ipswich; whilst in South Scotland progress has been so rapid that only 36 miles remained. South of the line, 30 miles in South-East England, and 159 miles in South-West England and South Wales were still to be acquired. Out of a total of 1059 miles of secondary or lower-voltage lines, wayleaves for 779 miles had been obtained at the end of December, 1931, and 424 miles were obtained during the year. In Mid-East England, North-East England, East England, and Central England, negotiations are now complete, while in North-West England, North Wales, and South-East England, only 56 miles remain. In the South-West England and South Wales and South Scotland areas considerable progress has still to be made.

Sites for 15,452 towers out of an estimated total of 17,265 required for primary lines and 6918 sites out of an estimated total of 8878 sites for secondary lines were secured by the end of 1931; while 178 sites were also acquired for transforming and switching stations, an increase of 61 over the aggregate recorded at the end of 1930. Eighty-five transforming and switching stations were in operation, 32 of which are in South-East England, 14 in Central Scotland, and 13 in North-West England and North Wales. Out of a total of 9865 wayleaves obtained in 1931, 97·64 per cent. were voluntary and only 2·36 per cent. compulsory. In Scotland and South-West England and South Wales, both notable for magnificent natural amenities, success was most marked.

Construction of main transmission lines advanced almost as rapidly as the acquisition of wayleaves, and at the end of 1931 1775·3 miles of primary line towers had been erected, an increase during the year of 1143·6 miles. The corresponding figures for secondary lines were 534·4 miles and 350·6 miles respectively. The cable system in South-East England, covering 241 circuit miles, represented principally by 33-kV and 66-kV cables, had reached at the end of the year a stage where only 17 circuit miles remained to be completed, and the construction plan for cables operating at 33-kV and below was almost finished. At the end of 1931 910 miles of transmission lines were in commission and an additional 43 miles had been energised and made ready for operation, compared with 464 miles in operation at the end of 1930 and 86 miles at the end of 1929. Primary lines in commission amounted to 604 miles and secondary lines for 306 miles.

It has been the policy of the Board to arrange and adopt its programme of construction so that advance temporary supplies of electricity may be obtained from some of the generating stations scheduled for operation under adopted schemes and given to undertakers whose generating stations have become insufficient to meet the growth of load in their areas of supply or who have urgently required supplies for the development of new areas. Up to December 31st, 1930, 24 undertakers were being so supplied, and the policy is stated to have resulted in the avoidance of the expenditure of nearly £1,000,000 by authorised undertakers on generators, boilers, and other equipment at comparatively small power stations, which will not be required when the Board's schemes are in full operation. During 1931 supplies were given to a further 21 undertakers, and as a result additional expenditure of some £1,250,000 which would otherwise have been required for the extension of stations, which will not be a service under the Board's operation, has been avoided by the undertakers concerned. Moreover, some undertakers have been enabled to provide for supplies in sparsely populated rural areas in which a public supply of electricity would not otherwise have been commercially feasible. At the end of 1930 the amount sanctioned by the Board for frequency standardisation work in progress or completed was £4,261,040, and at the end of 1931 this figure had increased to £8,067,919, leaving about £10,500,000 still to be sanctioned for those undertakings in respect of which the Board has issued requirements under Sec. 9 of the Electricity (Supply) Act, 1926.

The installation of new electrical equipment, particularly in industrial plants, has been an important factor making for improvement of competitive efficiency, while many firms have at the same time reorganised their manufacturing plants on more modern lines. At the end of 1930 the total value of contracts placed by the Board for the construction of the "grid" was £18,264,829, and at the end of 1931 £21,848,869, showing an increase of £3,584,040, and primary lines, including sub-stations, accounted for £15,528,114. Practically all the contracts for the main transmission system have now been placed, the last important contract given being for the South Scotland scheme in October, 1931. The contracts to be placed in the future will be for the most part in respect of secondary equipment in connection with lower voltage lines and sub-stations. Without exception, all the contracts were placed with British firms.

The report gives details of the progress in the individual areas, but we shall not attempt to do more than direct attention to some of the outstanding facts. At the end of 1930 the Central Scotland scheme was almost completed; 219 route miles, or 254 circuit miles, of 132-kV lines had been constructed, linking up eleven transforming stations. During 1931 21 route miles of 132-kV lines, linking up Dundee and Abernethy, were completed, and two 132-kV transforming stations were put into commission at Dunfermline and at Dundee, thus completing the system in Central Scotland. The standardisation of frequency was accelerated, with the result that at the end of 1931 consents totalling £2,163,000 had been granted. Contracts for the conversion of generating plant had practically all been placed, and modification of equipment used in interconnection and distribution was far advanced. Work was proceeding actively on the conversion of consumers' apparatus, and many large installations were changed over during the year, principally in the iron and steel industry. Experience of the "grid" in operation in the area has called for few technical modifications, and apart from one or two operational mistakes, inseparable from the initial handling of plant of new type, operation has been satisfactory.

The South Scotland scheme provides in its adopted form for the construction of 230 miles of 132-kV lines, 146 miles of lower voltage lines, and thirteen sub-stations. The construction of the primary line from Dunston (Newcastle) to the Scottish border near Coldstream, involving the addition of a transformer switchgear and connecting lines at Dunston, has been undertaken as part of the operations in the North-East England area. Provision was made during the year for the immediate construction of a secondary line from Carlisle to Gretna to supply energy to the Dumfries County Council for the development of a section of the distribution scheme which the Council has prepared for the entire county. By the end of the year the acquisition of wayleaves was far advanced, and contracts covering the primary lines had been placed.

In the North-East England area progress in construction during the year was so rapid that all the primary lines and all secondary lines, with the exception of 1·7 miles, were completed, and the lines in operation aggregated 23·6 miles. Construction was begun on the 56 miles of primary lines from Dunston to the Scottish border, provided for in the South Scottish scheme. Of the seventeen transmitting and switching stations required under the scheme five are in operation; five more will soon be giving supplies to Malton and Northallerton; five more are in the course of construction; and work on the remaining two will be begun as soon as negotiations are completed with the undertakings concerned. The expenditure for standardisation of frequency sanctioned by consents during 1931 amounts to £2,316,603, which, added to the previous year's figure of £1,769,160, brings the total expenditure sanctioned to £4,085,763, a large proportion of which is for the provision of plant and equipment which at some later date will be required to meet increased demands for supplies of electricity. The change over is proceeding rapidly, and special efforts are being made to convert generating plant as quickly as possible, because the changing of consumers' equipment is dependent upon the provision of adequate 50-cycle supplies. During the eighteen months that have elapsed since the inauguration of the standardisation programme in this area, specific approval has been given for the change over of 6500 motors, aggregating 131,000 H.P., representing fully 20 per cent. of the total capacity of the motors to be converted in the area.

In North-West England all wayleaves required for the 132-kV lines were obtained and only 13·6 miles were still under negotiation for secondary lines at the end of the year. The most interesting feature of the overhead constructional work is the river Ribble crossing at Preston—Fig. 1—where considerations of clearance for the masts of shipping

FIG. 1—THE RIBBLE CROSSING AT PRESTON

FIG. 2—TERMINAL TOWER AT YARMOUTH

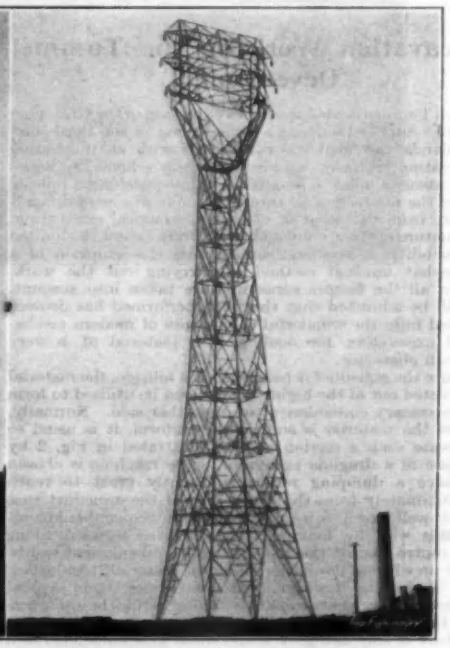


FIG. 3—RODING CROSSING TOWER

made it necessary to keep the conductors at a minimum height of 260ft. above high water level, and this entailed the provision of high towers on each bank. The towers are 239ft. high, with a base width of 60ft. The span between the two towers is 720ft.; the approach span on the north side is 1618ft., and that on the south side 1710ft. Bores taken on the site of the tower foundations on the north bank showed the presence of rock at 11·4ft. below Ordnance Datum, with gravel between the rock and the ground surface. Engineers who have had experience of the ground in this neighbourhood stated that underground streams made the gravel unreliable and unsuitable for the use of concrete piles, as normally employed, this consideration applying particularly to the foundations for the two legs of the tower nearest the river bank. It was therefore decided to sink wells, 12ft. in diameter, for these two foundations, the wells being taken down to 13·92ft. and 13·12ft. below Ordnance Datum and filled with concrete. At the end of the year there were 58·4 route miles of transmission lines operating at 33 kV; 23·6 route miles at 11 kV; and 1·4 miles of cable operating at 6·6 kV. Considerable progress was made in the standardisation of frequency in the area of Stalybridge, Hyde, Mossley, and Dukinfield undertaking, and approval covering the conversion of all generating plant and the greater part of the equipment required for interconnection and distribution has now been given The change over on consumers' premises was begun early in 1931, and is proceeding satisfactorily.

The Mid-East England scheme provides for the construction of 323 miles of primary lines, operating at 132 kV and 202 miles of secondary lines. At the end of 1931 all wayleaves for both primary and secondary lines had been obtained, and 309 miles of towers for primary and 169 miles of secondary lines had been erected. Constructional work for the whole scheme will be virtually complete in 1932. During 1931 96 miles of 132-kV lines were put into commission, and 40 miles of 33-kV lines were constructed. Construction also proceeded on twelve 132-kV transforming stations and on twelve of the sixteen secondary switching and transforming stations. Seven of the 132-kV stations were completed and five of them were in service. The transforming station at York is of special interest, since, in addition to the 132-kV equipment, it includes 66-kV outdoor switchgear to give supplies to various parts. The connections to the selected stations in this area also proceeded satisfactorily and were completed in unison with the completion of the associated overhead lines and transforming stations. The high crossing of the river Ouse required two towers with a height above ground of 298ft., and for the river Trent one tower with a height above ground of 254ft. There are six 33-kV transforming stations in the South Lincolnshire area.

At the end of 1931 all the wayleaves for the construction of 415 miles of "grid" lines for the Central England electricity scheme had been obtained, despite the complications arising from the fact that large industrial regions, with densely populated centres, are interspersed with highly cultivated agricultural territory. Construction of the lines advanced so rapidly that at the end of the year 364 miles of towers for the 132-kV and the whole of the 33-kV lines had been erected, leaving only 34 miles of primary lines to be completed. The primary lines connecting the Central England "grid" system with those of the South-East England, North-West England, and North Wales and South-West England and South Wales systems at Bedford, Crewe, and Gloucester respectively, had been practically completed at the end of the year. Over 104 miles of primary lines were put into service, and the eighteen transforming stations specified in the scheme made rapid progress towards completion. Seven of them having an aggregate capacity of 480,000 kVA were put into service. Five generating stations in the area, with an aggregate plant capacity of 390,000 kW, were linked to the "grid" system. The standardisation of frequency in the area involves the conversion of about 450,000 H.P. of electric motors, and roughly 338,000 kW of generating plant, at an estimated cost of £4,336,700. To carry out this work a scheme was prepared and accepted, and arrangements were made with the two principal undertakers concerned, namely, the Birmingham Corporation and the Shropshire, Worcestershire and Staffordshire Electric Power Company. By the end of the year over 1500 approvals had been given by the Board for frequency standardisation, at an estimated expenditure of £1,426,935, and conversion had been completed in an area of 140 square miles out of the 300 square miles affected, the plant of some 4460 consumers and some 36,000 H.P. of motors having been changed over.

In East England all wayleaves required for primary and secondary lines, 139·6 and 14·5 miles respectively, had been obtained at the end of the year. For the primary lines 105·4 miles of towers had been erected, leaving only 34·2 miles of primary lines and 14·5 miles of secondary lines to be constructed. The three 132-kV transforming stations at Norwich, Yarmouth, and King's Lynn, as well as the 33-kV station at Bury St. Edmunds, were nearly completed at the end of the year. Although no supplies were being given in the area, arrangements had been made for a supply to Bury St. Edmunds, whereby the Board would use and ultimately acquire from the Ipswich Corporation and the East Anglian Electricity Company a 33,000-volt line linking up Ipswich and Stowmarket, from which place the Board is constructing a line to Bury St. Edmunds. In this area there are some interesting river crossings.

In South-East England, which is one of the most difficult areas from the point of view of wayleaves, progress during 1931 was very satisfactory. By the end of the year wayleaves for only 30 miles of primary lines and 42·8 miles of secondary lines remained to be acquired, and 370 miles of primary lines and 114 miles of secondary lines had been erected. In the Outer London area primary lines in commission and operating at 132 kV linked up Luton-Bedford, Bedford-Little Barford, Little Barford-Peterborough, Brighton-Eastbourne, Eastbourne-Hastings, Hastings-Folkestone, Barking-Rayleigh, Eltham-Northfleet, and Northfleet-Tunbridge Wells, a total of nine sections with a mileage of over 199. Five further sections totalling 92 miles are ready for operation, and seven sections, totalling 140 miles, are nearing completion.

In the Inner London area cable laying was practically completed, with the exception of the very difficult section from West Ham to Stepney, which necessitates the provision of a number of special cable bridges over docks, canals, and the river Lea. Satisfactory progress was made with the twenty-one transforming and switching stations in London with the exception of those at West Ham, Stepney, and Bankside. Property standing on these sites had to be purchased, and it has been very difficult to displace the tenants in order to obtain possession for demolition purposes. At Stepney and Bankside the difficulties have been largely overcome, but at West Ham steps have had to be taken to make a connection to the generating station without the installation of main switchgear, as a temporary measure. Owing to unforeseen difficulties in giving the contractors access to the site, and in preparing the foundations, the expectation that the permanent control room at Bankside would be completed during the year was not fulfilled. It is, however, expected that the building will be available by the summer of this year.

The Northfleet transforming and switching station, which at present is the largest on the "grid," was completed. Seven circuits radiate from it over five transmission routes, and provision is made for two other circuits. But although the station at Northfleet is the largest 132-kV switching station from the point of view of area and number of switches the Barking transforming station has the largest installation of transformers. There are four 60,000-kVA and six 30,000-kVA units. Four of the 30,000-kVA transformers are directly connected to the 60,000-volt circuits going westward to London, the remaining six transformers being directly connected to 132-kV lines running to Brimsdown, Rayleigh, and Northfleet. At the end of the year designs were completed for the two towers required for the river Thames crossing. A smaller but quite spectacular crossing has been completed over the navigable part of the river Roding at Barking Creek. Considerable progress was made by the London Power Company on the construction of the Battersea generating station, and by the County of London Electric Supply Company in the extension of its station at Barking. The first section of the extensions to the Fulham generating station, amounting to 124,000 kW, is being designed, and additional plant for the selected stations at Brighton, Battersea (Borough Council), Hackney, Croydon, and Luton has been installed and is now in commission. The extensions by the London Power Company to the Deptford West generating station and by the North Metropolitan Electric Supply Company to the Brimsdown generating station are now nearly completed.

The South-West England and South Wales scheme provides for the construction of 651 miles of primary and 110 miles of secondary lines. At the end of 1931, 492 miles of wayleaves had been obtained for primary lines and 15 miles for secondary lines. The area shares with Scotland the distinction of having had the fewest number of compulsory wayleaves. Negotiations with landholders were carried out with celerity, and in one or two cases small deviations from the routes originally proposed were made to preserve local amenities. During 1931, 15·7 miles of 33-kV lines were put into commission, together with three 33-kV transforming stations at Bath, Neath, and Swansea. Supplies were given by the Board to Neath Rural District Council from Swansea, and the West Wiltshire Electric Light and Power Company was obtaining additional energy from Bath *viâ* Melksham. A number of authorised undertakers in the area operating on a non-standard frequency, principally the South Wales Electrical Distribution Company and the Cornwall Electric Power Company, have been active in carrying out the work of conversion.

The construction of the "grid" is still proceeding without any major alterations in the original basic design. Experiments with modified conductors have shown that only minor changes are required in order to preserve the good features of the original conductors, and at the same time to give increased protection to the steel core against corrosion. The National Physical Laboratory has issued an informative report on tests made in Scotland on different classes of insulators with a view to determining the most suitable type for use in districts where the atmosphere is subject to fog and pollution, and the tests have indicated that certain kinds of insulators will probably be more suitable than the ordinary type. Further observations are being made upon the test insulators to obtain a more extended knowledge of their characteristics under fog conditions, and it is hoped that the outcome of the investigations will be that a high factor of safety against flash-over in fog can be guaranteed without frequent cleaning.

Considerable experience of the characteristics of protective systems has now been obtained. Line faults which have occurred in fog and during lightning have been cleared from the system without material damage to conductors, arcing devices, or insulators, and the faults have also been cleared without causing instability of the power plant. Although some difficulties have been experienced in obtaining accurate discrimination they are gradually being overcome. The development reported in the third annual report, whereby potential supplies for distance relays can be taken direct from the 132-kV system, has now been completed, and some of the apparatus is in service. As the result of this development the necessity for providing supplementary lower voltage lines to give supplies to sub-stations has in one case been obviated by taking these supplies from a potential transformer connected to the 132-kV lines.

In the South-West England area the one circuit breaker type of station, which was previously con-

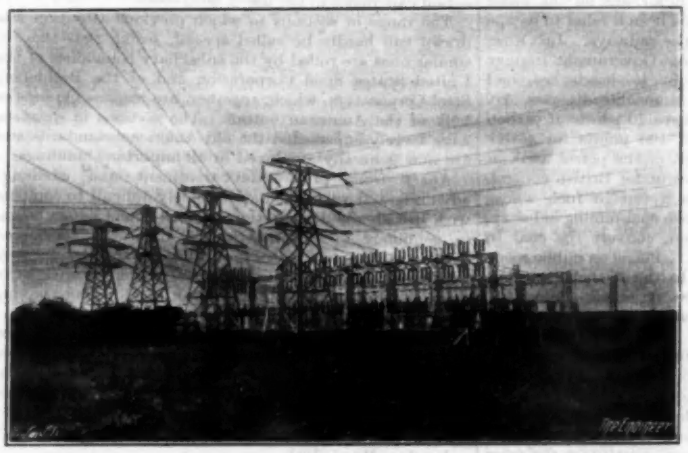


FIG. 4—NORTON-ON-TEES 132-kV SWITCHING STATION

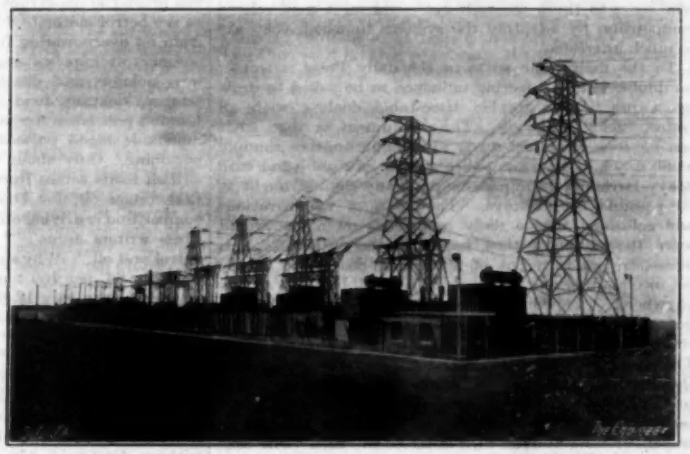


FIG. 5—BARKING 132-kV TRANSFORMING STATION

fined to lower-voltage lines, has been applied to 132-kV lines. The one circuit breaker station is the cheapest type of switching station that can be used for tapping the 132-kV lines for important supplies. At present it is only used for supplies to comparatively small undertakings, and the designs are such that the sub-stations can readily be altered to the standard three circuit breaker construction should that be necessary as the result of development of supply or for other reasons. Metering equipments of all types called for by the requirements of the Electricity (Supply) Act, 1926, have been supplied by four manufacturers. The report contains a number of interesting illustrations, some of which are reproduced in Figs. 1–5. The first shows the Ribble crossing at Preston to which we have alluded. Fig. 2 is a terminal tower at Yarmouth, which spans the roadway at the base; Fig. 3 one of the Roding crossing towers, which is 360ft. high, the span across the river being 1800ft. Fig. 4 is the Norton-on-Tees 132-kV switching station, and Fig. 5 the Barking 132-kV transforming station with a capacity of 420,000 kVA.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ROAD VEHICLES ON RAILWAYS.

SIR,—Your editorial footnote to a letter on page 312, March 18th, 1932, referring back to a valuable little article on "Self-propelling Vehicles on Railways," page 676, December 25th, 1931, is very timely, and it seems, at least to me, a pity that this article could not be read by the numerous journalists and others interested in petrol and electric transport, who, in the Press, are so constantly writing up the need of petrol, oil, or electricity for frequent services on main lines. The article mentioned would enlighten many motor engineers and electricians who seem to think the railways could meet road-vehicle competition by adopting the systems in which they are so much interested.

To the many who write in the daily Press it would, no doubt, have a sobering influence to be asked to draw up a practicable graphic time-table dealing with all trains, including goods. Their argument is that what can be done on public roads with motor coaches running at 60 m.p.h.—when the police are out of sight—and with heavy lorries at 40 m.p.h., without any signals, ought to be possible on railways. The risks of conflagrations and collisions, now a daily occurrence on roads, would scare the public if they happened on railways. Yet, women riders turn out of a burning coach and gladly get into another one that may be a wreck before it arrives anywhere. Crowding in coaches pleases the public; but on the railways passengers try to monopolise an entire compartment by covering the seats with their baggage. The *état d'âme* of people in road coaches changes at once they get into railway cars. Petrol racing has become a ruling mania, deliberately fanned by the daily Press and causing discontent with the uneventfulness of railway travel, with its absence of sensations *en route*. One asks of what avail is it to spend five hours on weary bumping over public roads in a luxury coach from London to Birmingham when it can be reached in two hours by rail and so give three hours longer for pleasure or business in London?

Certain daily papers carry on a constant propaganda for electrifying the railways, either by steam-power stations or by means of an electric drive between the wheels and the Diesel motors aboard the train. But it "must" entail electric plant of some kind, they urge.

So insistent is this Press campaign that it might be well if those who promote it would trouble to read of railway experience in France and Germany, with electrification and Diesel oil motors on trains. British railways cannot afford to ignore that valuable experience which has resulted in the introduction of very much more efficient Continental steam locomotives as the only way now commercially practicable on main line railways.

But without any change of their existing power systems, steam or electric, the railway decline throughout the world, caused by road competition, must, to prevent collapse, be arrested by means of some radical alteration of their transport system which will merge the railways with the roads, in such way that road transport companies will then find it cheaper, quicker and safer so to dispatch their vehicles that their maximum daily mileage can be made on the railways instead of on public roads and express goods be conveyed from door to door quicker than passengers can be transported between the same points by all-road services.

Already many electrified tramway lines have shown that, on the same routes, with the same speeds and same fares, travel on pneumatic-tired "trolley" vehicles is more popular than on steel tires. The change gives curb-to-curb conveyance, and where the electric current ends the vehicle can be run by petrol. This conversion, but for curb-to-curb conveyance of long-distance passenger services over the railways, without change of seats, change of wheels or of tires, and without the A.D. 1808 system of "containers"—which involves delays in goods yards and double slinging of the containers by cranes from truck to truck on each round trip—is now being considered by railways here and on the Continent. The conditions are stipulated that such door-to-door and street-to-street and terminus-to-terminus transport of railway vehicles on pneumatic tires must involve no change to the existing steel railway tracks or their mechanisms, no impediment to the inspection and repair of existing tracks and no alteration to existing locomotives and steel-tired rolling stock, save adaptor-buffers and couplings on some guards' vans. Passengers must not have to wait on terminus, or other station, platforms, and goods must not be delayed in delivery after the lorries are detached from the trains.

Tramway lines are being pulled up all over England, and also railway lines in Ireland. This door-to-door railway transport system leaves railway tracks intact. The system has been alluded to in various places. The article by Mr. Green, page 676—*ante*—speaks of the much-advertised L.M.S. Railway "Ro-railer," "and other, similar, projects . . . being tried abroad." At present, silence promises more success than Press puffings; but, now that the Transport Ministry is trying to conciliate road and rail interests, this scheme of motor roads on railways appears to bridge over their rivalries. Throughout the world railways are steadily declining. Financial papers reported an aggregate loss by the world's railways, through road competition in 1931, of over £100 millions. British railways figured for £16 millions. Iron, steel, coal and heavy engineering industries fell with the railways. Motor trades prospered with the falling industries. To the newspapers and motorists the railways appear "out of date," because they do not employ petrol or electricity for frequent—say, five-minute—light trains from London to, let us say, Penzance or Thurso. Mr. Green shows the ignorance of such writers. Sir Josiah Stamp, in the *Observer*, has replied to that "electrical enthusiast," Sir Phillip Dawson, and to the "active Diesel propagandists," and he points to the 170 rail-motors in use since 1907. Steam coaches can be run by one man if an automatic stoker is used—see page 380, October 12th, 1906. On the branch line, Oxford to Cambridge, *viâ* Bletchley, the Michelin rubber-tired petrol autobus necessitates two men, the conductor being required to lower the fold-up step ladder at "halts," with ordinary trailer coaches.

The danger of petrol on railways must also be considered. Lighting gas—less explosive—is condemned on railways. Is there known to man any form of motive power that has proved so dangerous on land, in air, and on the water as the petrol motor? So far, it has been a relief to escape from its overpowering fumes on the railways. Just now, coroners at inquests are calling for Government inquiry into sickness and death caused by it—headaches, bad temper, sickness, food loathing, stomachic diseases, &c. London policemen are stated to have 70 points of carbon monoxide blood poisoning out of 100 points for active poisoning. Only about 6 per cent. of the petrol used on British roads comes from countries under British control. Like crude oil, for Diesels, it is a foreign fuel, whose competition is driving out the British coal-mining industry. Press writers argue: "Well, then, convert the coal to petrol and oil." Why such waste? Petrol on public roads costs 2s. 6d. per 100 ton-miles. In the Michelin autobus on rail it costs only 1s. 6d. per 100 ton-miles. Before the new duties, Diesel crude oil in road vehicles cost 6d. per 100 ton-miles.

Figures published in THE ENGINEER show that Diesel oil in Diesel motors in railway service costs 50 per cent. more than coal in English locomotives, and 75 per cent. more than coal in Continental locomotives. Diesel oil, ex tanker in most world ports, has, for years past, cost, without duty paid, 87s. 6d. per ton—four times the price of British smokeless coal. Smokeless coal, at 20s. per ton, costs 1d. per 100 ton-miles on railways.

Mr. Green, in his article, page 676, says: "Road companies can offer door-to-door service which a railway by its physical limitations cannot possibly offer." In the Sentinel-Cammell steam rail-car catalogue we read: "Railways cannot give that door-to-door service." In the recent book, "Wealth of Peoples," by H. G. Wells, we read that railways are suffering because their tranports are limited to the places served by the steel railways. The first country to change that notion appears to be Russia, where attachment to Trevithick's system of 1805 seems to have been severed—at least, experimentally—by the use of motor roads clipped on to the sleepers of steam railways. A member of the Railway Commission from Leningrad, recently in London to study traffic problems here, stated that the system they are planning or using is similar in principle, if not in detail, to that described in THE ENGINEER, page 251, September, 1931. It is claimed that these motor roads on railways conciliate the rival interests of road and rail transport companies.

S. D.

Haverstock Hill, N.W. 3, March 19th.

OIL-ELECTRIC LOCOMOTIVES.

SIR,—I notice in THE ENGINEER of January 29th, an article from a correspondent headed "Railways and Oil-electric Locomotives." There are two or three statements in this article that are somewhat misleading, and in the general interest of the art, I would like to correct them.

To begin with, a statement is made that the annual cost for repairs on the Illinois Central Railroad is £1065. As a matter of fact, they have six 600 horse-power locomotives, and up to January 1st, 1932, they had been in actual service 70,954 hours. These locomotives were bought at various times, and this represents 76 per cent. of the actual calendar hours from the date of purchase and the total cost of labour, material and inspection; in fact, all out-of-pocket expenses except operating crew wages, came to exactly 60 cents per hour, which, in American practice, is considerably less than the equivalent steam operation.

A statement is further made that exceptionally high hours of service per month have been obtained by some railways, notably the Chicago and North-Western with 492 hours. "It would appear that these are isolated cases for one month only." One rolling mill which has had six of these locomotives in service over a period of two and one-half years, averages 645 hours per month per locomotive. You will note that the figures quoted above for the Illinois Central also show an average service of 547 hours per month per locomotive for a period of two years.

It is also inferred in a statement that there has been considerable broken crank shaft trouble. There are 106 300 horse-power Ingersoll-Rand locomotive oil engines in service, some of them for seven years, on which there have been three broken crank shafts, all due to an early error in design, which was corrected some time ago.

It is also stated that the 750 horse-power freight locomotive on the New York Central Railroad has had a high maintenance cost and relatively low mileage. This locomotive was the first of its type and admittedly experimental. During the past year its mileage was 10,601. The pistons are cooled by a spray method. The second locomotive of this design is rated at 800 horse-power. It went into service on April 18th, 1931, and on January 1st, 1932, it had completed 5298 hours of service, or an average of 640 hours per month.

INGERSOLL-RAND COMPANY,
Locomotive Department,
L. G. COLEMAN, Manager.

New York, N.Y., February 29th.

BRITISH AND AMERICAN ROLLED STEEL SECTIONS.

SIR,—While I have no desire to enter into a prolonged correspondence on the above subject, Mr. B. L. Hurst's letter in your issue of March 18th calls for one or two comments.

The use of the same unit stress for American and British Standard steels is not confined to American engineers, but is general practice, not only in strictly neutral markets, but also in British Dominions and Colonies, which have had actual experience in the use of both steels.

The range of sections to which previous attention was drawn can hardly be called special, seeing that they or similar ones are rolled by the subsidiary companies of the United States Steel Corporation and of the Bethlehem Steel Corporation, which, together, are responsible for the bulk of the American output. The sections in question have largely superseded the old American standards and are now generally employed in all important buildings.

Apart from preferential treatment and exchange advantages, it will be found extremely difficult to compete with British standard sections against broad flange beams in genuinely open competition. It is the considered opinion of many engineers that if broad flange beams were available in this country the demand would be such as to cause the present range to disappear, in addition to having a marked effect on the export trade.

The old American heavier-than-standard sections were included because they were very useful in such cases where a special load had to be carried, and it was more convenient to use the same depth of beam, even at some sacrifice of efficiency, as the adjacent minimum weight section.

H. R. WHITE, M.I. Struct. E.

London, March 19th.

JOHN HENRY HAMILTON.

SIR,—With reference to Mr. Hugh Campbell's letter in your issue of March 11th in regard to Mr. Hamilton's appearances before the technical institutes, I should like to put on record that Hamilton took part in a discussion on Mr. H. A. Humphrey's paper on "Power Gas and Large Gas Engines," which was read before the Institution of Mechanical Engineers in 1902, and which was referred to in your obituary notice of March 4th.

Mr. Hamilton also on one occasion wrote a paper on "The Gas Engine in Iron and Steel Works," which he read before the Staffordshire Iron and Steel Institute at Dudley on November 26th, 1904.

He occasionally attended the meetings of the local Engineering Society in Nottingham, but apart from the other occasion mentioned by Admiral Harrison, I do not know of any other public appearance during the thirty-four years in which I was closely associated with him.

J. W. GIBBONS.

The Premier Gas Engine Company, Ltd.,
Sandiacre, near Nottingham,
March 21st.

LIGHTER ROLLING STOCK.

SIR,—If it ever comes about—as seems quite within the bounds of possibility—that express trains become lighter, faster, and more frequent, I should like to point out that the advent of the booster has put quite a fresh complexion on the question of the suitability of my design for a four-cylinder 4–2–4 locomotive with 8ft. driving wheels, which was illustrated in THE ENGINEER for February 27th, 1920, and discussed in several succeeding numbers.

The dead weight of the present trains might be greatly reduced if the bodies of third-class carriages were constructed on the lines of the road coaches, retaining the present underframes. Separate light seats for each passenger would be far more comfortable. In the unlikely event of experimental ones proving unpopular, they could always be utilised on short-distance "motor trains."

C. F. DENDY MARSHALL.

Guildford, March 19th.

Railway and Road Matters.

A NEW method of operating street signals was inaugurated on March 14th at the junction of Cornhill, Gracechurch-street, and Leadenhall-street, in the City of London. The signals are operated, by the pressure of passing and approaching vehicles, on electrical contacts under the roadway.

THE Great Western Company has the two laurels of (1) the fastest non-stop passenger train run in the world, and (2) the fastest freight train in this country. It can now add thereto a third—the longest non-stop freight train run in this country. This is made by the 11.35 p.m. vacuum-braked goods train from Paddington to Newton Abbott, which runs from Acton to Taunton—152¼ miles—without a stop.

A FORMER well-known figure at the old half-yearly meetings of railway companies passed away, in the person of Mr. E. R. McDermott, on Thursday, March 10th. He and his late brother, Mr. Fred McDermott, were the editors of the *Railway News*, which was established by their father, Mr. Edward McDermott, along with Dr. Samuel Smiles, of "Self Help," the then Secretary to the South-Eastern Railway.

IN our Annual Article "Railways in 1931," in THE ENGINEER of January 22nd last, we mentioned that the Bricklayer's Arms Goods Station of the former South-Eastern and Chatham and the Willow Walk Goods Station of the London, Brighton and South Coast, which are practically side by side, were to be combined into one large yard. This has now been done, and the new station was officially opened on March 8th.

THIRTEEN bodies of Traffic Commissioners, said Mr. Pybus the other day, are now entrusted with work which was formerly performed by some 1300 different local authorities, who were in many cases themselves interested in local transport. Apart from their interests as owners of tramways, local authorities now own about 5000 road vehicles for the conveyance of passengers, or substantially over one-tenth of the total number of public service vehicles in the country.

THE Southern Railway Company's report for the year 1931 shows that the gross receipts from railway working proper, *i.e.*, independently of such ancillary businesses as docks, steamboats, hotels, &c., were £21,226,487, as compared with £22,395,928 in 1930, and the expenditure thereon to have been £17,195,442, as compared with £17,928,352. Thus the net receipts for 1931 were £4,031,045, as against £4,467,576. In the ancillary businesses, the profit of £418,022 from steamboats in 1930 became one of £279,704 in 1931, and that of £305,749 from docks in 1930 became £293,608 in 1931. The Southern Railway is less affected by the trade conditions in the hotels and refreshment room business, as most of that work is let to contract.

THE compulsory appointment of a receiver for a railway company, whilst still often done in the United States, and particularly during the last three or four years, is a rare event in Great Britain. We regret, therefore, that it was found necessary, in the Chancery Division, on March 15th, on the petition of the Southern Railway Company and of some debenture stockholders, to appoint a receiver and manager for the Kent and East Sussex Railway. This railway serves a useful purpose, in that it shortens the length of the two sides of the triangle, the base of which is Hastings-Ashford, the apex being Tonbridge. It runs between Robertsbridge, on the Tonbridge-Hastings line, and Headcorn, on the Tonbridge-Ashford. It was one of the late Colonel H. F. Stephens' activities, and has been badly hit by road competition and agricultural depression.

HEREIN, on February 26th, we quoted from the annual report for 1930–31 of the South African Railways to the effect that the Natal main line electrification scheme was to be added to by the extension of the length—of 26 track miles—between Masons Mill and Cato Ridge. The merit of this scheme lies in the fact that it will enable a saving of approximately £40,000 to be effected in the operating expenses of that section of the Natal line. Under electrification conditions a train of 1500 tons will be hauled in unbroken loads from Glencoe to Durban, and 900 tons in the up direction, thereby avoiding the considerable amount of shunting and remarshalling of trains now necessary at Masons Mill and effecting substantial economies in running expenses, owing to the reduced time required for the round trip. The traffic will be hauled by the existing electric locomotives, and the "24" class steam engines now employed on the Cato Ridge section will be released.

MENTION was made herein on September 11th last of the provision of some new signalling by the London, Midland and Scottish Railway at Mirfield in Yorkshire, where the original Manchester and Leeds of the Lancashire and Yorkshire is crossed diagonally by the London and North-Western's Huddersfield and Leeds. There are many new features in this signalling, and some were described, but their relation not definitely mentioned, on March 14th, in a paper read before a joint meeting of the Institute of Transport and the Institution of Railway Signal Engineers. The novel feature is the absolute departure from the hitherto standard practice of telling a driver where he is going by means of the relative positions of the signals—the signal on the right applies to going to the right, and that on the left for going to the left. Added to this, the arms vary in height in comparison with each other to show their relative importance—a higher signal is for a faster movement. Now, the top light of three signals, or the upper of two, will always indicate, when at "clear," that normal speed may be maintained. The lower light calls for medium speed. Sometimes there is a third, low-speed signal, which is also used for shunting. It is obvious that such a departure as this will greatly simplify the signal indications and reduce their number. Whether or not there is any ground for the fears of the old school of thought that a driver wants to be assured that the signalman has set the road for the direction he wants will soon be seen; anyway, if the road is set incorrectly and the driver obeys the speed indication shown him, he can meet with no harm, as the section on to which he will be turned must be clear.

Notes and Memoranda.

IT is said that the quartzite of Montana, U.S.A., has such a high compressive strength, 63,000 lb. per square inch, that a column of it would have to be built up to a height of over 10 miles before the base would fail by crushing.

A STRIKING use of aerial photographs of forest country is that the height of trees can, under certain conditions, actually be measured from the photographs. On the oblique photographs the height can be ascertained by direct measurement and on the vertical photographs it can be calculated from the length of the shadows.

ACCORDING to Dr. Sommerkorn, the technical, commercial, and industrial success of the hydrogenation process of coal has been proved at the Louna Works in Germany, both in regard to coal and mineral oils, and that it is beyond question possible profitably to obtain the important results of the process from the smaller hydrogenation schemes that would be suitable for countries such as South Africa.

A STEEL arch bridge was recently constructed over the Merrimack River in Massachusetts by rather unusual methods. Falsework was put in the river and the deck of the bridge was erected thereon. The hangers from the arch were put in place and finally the arch was built on these hangers on struts. Then, when the arch was completed, the load was transferred, as tension, to the hangers and the falsework removed.

THERE was an interesting discourse on large telescopes before the Junior Institution of Engineers, by Mr. C. Young, of Sir Howard Grubb, Parsons and Co., Ltd., on March 11th. In his remarks the lecturer said that the refracting telescope at the Lick Observatory, which is 40in. in diameter, involved nineteen failures in the founding of the glass, and ultimately involved a cost of some £10,000. On the other hand, had the reflecting principle been adopted the cost would have been about £1200. The lecturer mentioned the fact that the 74in. reflector which is now being made in this country for the Toronto University will be the second largest in the world.

THE most important, as well as the most expensive, item connected with the general overhaul of a locomotive is, says Mr. J. R. More, of the South African Railways, the boiler repair. The value of the boiler of a large modern locomotive is generally over a quarter of the total cost of the engine, and the time taken to repair a locomotive is in most cases governed by the extent of the repairs to the boiler. In order to expedite the passage of engines through the workshops, it is usual to hold in stock and ready for use spare boilers of different classes, which are exchanged with the boilers removed from engines undergoing heavy repair. The boilers replaced are repaired in sequence of urgency and are then included in the spare boiler stock.

IN the March issue of the *British Russian Gazette* there is a very interesting article on tea growing in Georgia. It would appear that Georgia can now produce only about one-twelfth of the Russian requirements for tea, which has heretofore been principally imported from China; but that strenuous efforts are being made towards native cultivation. Fowler's "Gyrotillir" is being used for the preparation of the soil and a German machine used for subsequent cultivation, while a machine of some promise seems to have been developed for the plucking of the leaf. We sense, however, that Dr. H. H. Mann, the author, rather deplores the passing of hand work in the tea plantation, although it is inevitable in Georgia on account of the dearth of labour.

THE Incorporated Association of Electric Power Companies, representing the premier statutory power companies of Great Britain, report satisfactory progress in their activities, particularly with regard to absorbing non-statutory private plant. During 1931, the peak period of depression, twelve of the associated power companies added, by taking over private plant alone, 88,910 H.P. to their ordinary supply. This represents 42,024 H.P. from previously privately owned electrical plant and 46,886 H.P. from privately owned steam and internal combustion plant, which, for economic reasons, has been changed over to electric power. Such advance gives a good indication of the steady development of the companies' resources.

A RATHER unusual form of "boiler" explosion is the subject of a recent official report. It concerns a 3in. stop valve and governor connected with a colliery screen engine. The valve cover blew off and a man was killed. The cover was attached to the body of the valve by a screwed spigot 3¼in. in diameter by ¼in. long with twelve threads per inch. In making the joint it had been the habit to smear the thread with manganesite, which sets very hard under heat and has adhesive properties, so much so that it required two men and a lever over 3ft. long to break the joint. It is suggested, as a consequence, that the thread was stripped when the cover was last removed and that the use of compound on the thread was unnecessary, as a good joint could have been made without it; also that a studded cover would have been preferable.

THE position which South Africa occupies in the field of mechanical and electrical engineering was the principal theme in Mr. W. G. C. Nixon's address before the Associated Scientific and Technical Societies, of which he has been re-elected President, summarised in the *South African Mining and Engineering Journal* of February 27th. Factors peculiar to that country necessarily limited mechanical and electrical practice. For instance, he pointed out in central power station practice Europe and America have steam boilers evaporating up to 500,000 lb. of water per hour, whereas in South Africa the largest unit in contemplation is to evaporate 180,000 lb., and there are few indeed above 45,000 lb. Steam pressures, too, remain low, for while most modern stations elsewhere are operating at from 500 lb. to 750 lb. per square inch, the highest pressure in use here is 360 lb. "Similar remarks," said Mr. Nixon, "apply to electric generators, the maximum size of which in South Africa is 32,500 kW, but in the main the instances given are not evidence of any lack of desire and ability to progress, so much as an indication that while our population remains small, rapid progress in size of units is impossible, in comparison with what can be done in great centres of population."

Miscellanea.

AN electrically operated conveyor capable of shipping coal at the rate of 1000 tons an hour has been started in work at the Cardiff docks. It is to be followed by others.

THE coal shipped from Sunderland last year amounted to 4,905,550 tons, an increase of 68,000 tons on 1930. It was one of the highest totals in the history of the Wear coal trade.

THE Government of Bhavnagar, near Bombay, intends to construct a new dock for ocean-going steamers at Ruva. There is to be a jetty 600ft. long, and the scheme is estimated to cost Rs. 30,00,000.

WORK is to be restarted at the manganese mines at Turtle Creek, near St. John, New Brunswick. The proximity of the Canadian National Railways will make it possible to haul ore for nine months during the year.

IT is noteworthy that the exhibition which is to be held in Copenhagen in September of British produce, will include an important section devoted to the textile trades, not only those concerned with finished produce, but also the machinery for its manufacture.

A GRAIN elevator of 2,000,000 bushels capacity and a large warehouse are to be put up at Windsor, Ontario. Each will have a separate dock on the water-front of the Detroit River. The docks are to be ready for work by June 1st and the elevator in August.

AN American firm is putting on the market a series of pipe fittings specially adapted for work where the joints are made by autogenous welding. The fittings are made of seamless steel pipe and have the ends chamfered to provide the V groove for welding. The fittings have the merit that the wall thickness is uniform.

IT is understood that the air mail service between Karachi and Bombay will commence before June next. But some delay seems to be inevitable for starting a weekly service between Karachi and Madras *vid* Bombay, because of monsoon difficulties in the Ghats. Therefore, that service is not expected to start until after the monsoon is over.

IT is said that a recent shipment of 900 tons of slag from the great dump of Palmer's Shipbuilding Company at Jarrow-on-Tyne, was the first to be sent to London. The tip contains some million tons of slag and it is being used for road-making purposes. Hitherto a large amount of slag has been imported into the South Country from Belgium.

IT is reported that in the Don basin, Moscow, and other areas, experiments are now being carried out on the underground gasification of coal. A special Commission has been set up by the coal section of the fuel department to carry out investigations, and separate coal mines are being assigned. It is expected that the actual tests will begin early in 1933.

THE London County Council has decided that the whole river wall of the Victoria and Albert Embankments shall be raised or modified. In addition, the terrace and parapet of the Houses of Parliament will be raised. Practically all the existing river walls are a foot lower than the statutory requirements. It is probable that the work will be begun next year.

THE Witkowitz Corporation of Czechoslovakia has recently received an order from the Technical Institute of Moscow for two complete Loeffler boilers. Each unit will supply 285,000 lb. of steam per hour in normal operation and a maximum of 350,000 lb. for short peak loads. The steam pressure will be 1900 lb. per square inch and the total steam temperature 932 deg. Fah.

RADIO sets and parts contributed the largest value of the production of the electrical apparatus industry of Canada in 1930, with telephone materials second. The value of radio production in this industry was 20,334,511 dollars, and that of telephones, switchboards, &c., 11,034,184 dollars. Insulated copper wire came third at 10,175,110 dollars, while other varieties of copper wire bring the total value for this product up to 17,436,000 dollars.

IT is announced from Germany that the rare metal gallium is being produced commercially at one-twentieth of its cost of a year ago, when it stood at 175 gold marks per gramme. Gallium has the remarkable characteristic that, while its melting point is about 30 deg. Cent., it does not boil until the temperature is raised to 2000 deg. Cent. It is consequently eminently suitable for filling quartz-thermometers for registering temperatures above 500 deg. Cent.

THE system of first-class provincial highways maintained by the Ontario Government now comprises 2438 miles of main roads, 828 miles of which are made of cement concrete, and 214 miles of asphaltic concrete. In a report just issued mention is made of the fact that in the past corners on main roads were too sharp; it is added that nothing less than a 500ft. radius curve would be allowed to-day on any new section of the main King's highways in Ontario.

IT is rumoured that there will be introduced in the House of Lords at an early date a Bill to consolidate the existing legislation on the subject of the disposal of trade waste and effluents. The Bill has been drafted by the Pure Rivers Protection Society, and is understood to give, so far as the majority of its clauses are concerned, statutory effect to the Second Report of the Joint Advisory Committee on River Pollution, which was set up some years ago by the Ministry of Health and the Ministry of Agriculture and Fisheries.

AN electric cell for the control of current flow, is to be introduced into the lifts of the new buildings now being built at the "Radio City," New York. The purpose of this cell is to protect passengers entering or leaving lifts from the power-operated doors. Light beams will be thrown across the entrance to the lift and focussed on to photo-electric cells in such a way that the passenger will intercept the beams when passing in or out. If a passenger or any other opaque object passes through the path of the beams, the shadow cast on the cells will hold the door open, or, if the door is closing, will stop it.

RAILWAY CARRIAGE AND WAGON WHEEL TURNING PLANT

CRAVEN BROTHERS (MANCHESTER) LTD., REDDISH, ENGINEERS

(*For description see page 347*)

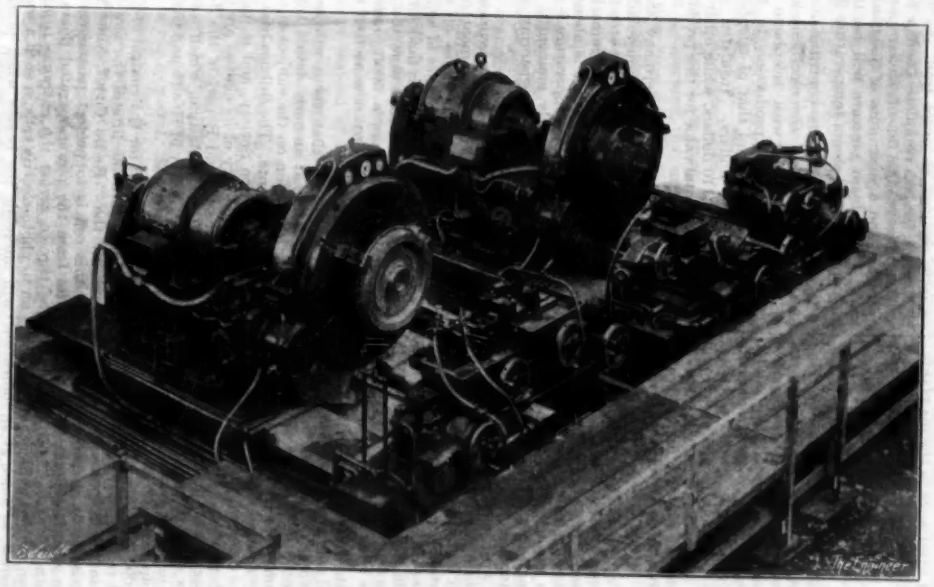


FIG. 1—VIEW OF COMPLETE PLANT

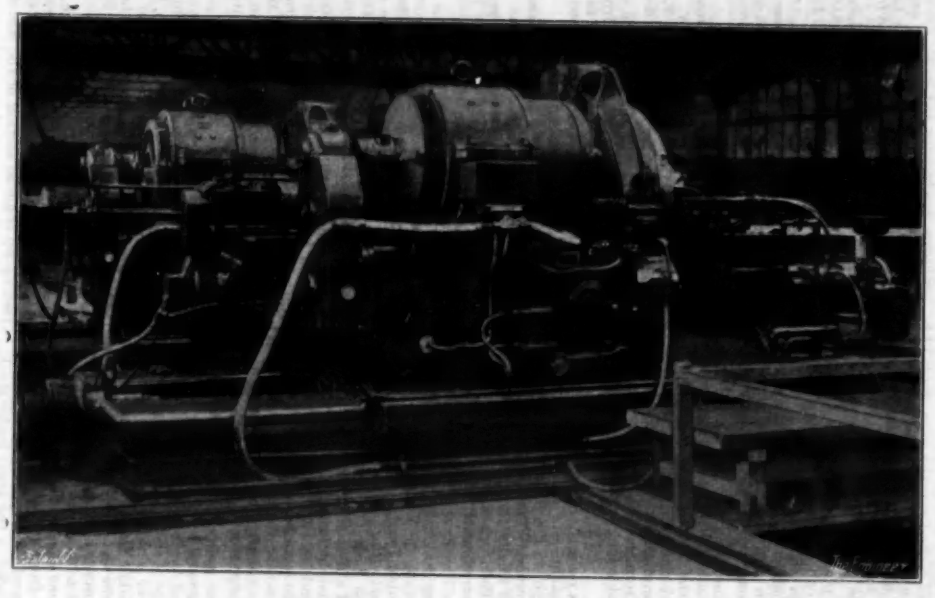


FIG. 2—SIDE VIEW OF COMPLETE PLANT

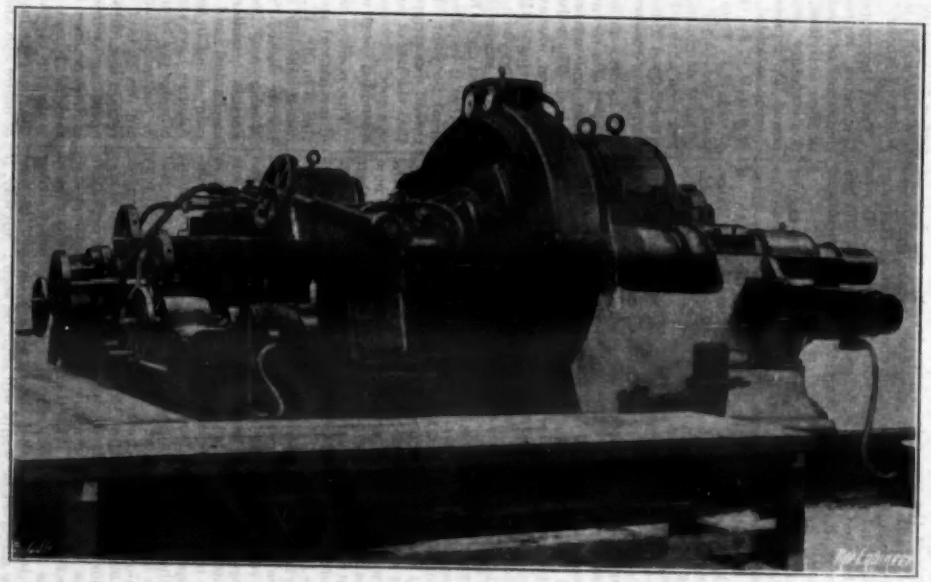


FIG. 3—SECOND OPERATION MACHINE

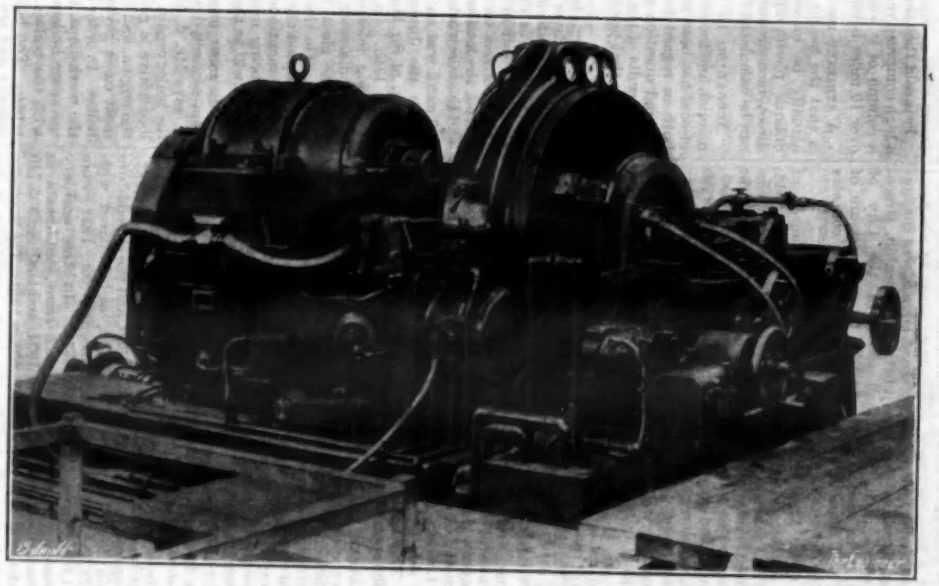


FIG. 4—FIRST OPERATION MACHINE

The Engineer

MARCH 25, 1932.

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

The Metallurgist.

THE MARCH NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

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THE MACHINABILITY OF STEEL.

FROM more than one point of view the discussion at the meeting last Friday of the Institution of Mechanical Engineers on Messrs. Robinson and Nesbitt's paper, "The Machinability of Steel as Indicated by its Macrostructure," was disappointing. At the Royal Small Arms Factory, Enfield, of which Mr. Robinson is the Superintendent, difficulty had been found in obtaining uniformly satisfactory results in the drilling of different batches of rifle barrel forgings in spite of the fact that all the steels were made to and fulfilled the same standard War Office specification. Neither microscopical nor chemical examination succeeded in revealing any reason why one supply of steel should give good drilling results, while another, apparently similar, supply should give bad results. It was suggested that the difference might lie not in the microstructure, but in the macro-structure. In the end a process of etching polished specimens with a standardised copper-bearing reagent was evolved. It was found that the steels which gave the best drilling results invariably showed after etching well-defined lines or bands running practically parallel with the axis of the bar. Steels which behaved unsatisfactorily in the drilling machine were, in general, difficult to etch, and always showed a forked and irregular band structure. With experience of the process it became possible to foretell from the etched macrostructure of a steel how it would behave in the drilling machine. Further, investigation showed that the deductions drawn from the etched macrostructure were applicable not only to the somewhat specialised form of machining involved in the drilling of rifle barrels, but could be extended to cover the general machinability of a steel. The theme is an interesting one, alike because of its novelty and because of its promise of high practical importance. Its reception last Friday was disappointing because many of the speakers in the discussion showed a more than usual tendency to wander into issues which did not concern it, and because it failed to evoke the slightest response from metallurgists. We were left lamenting that a really "hot" subject should be so unworthily treated.

Of those opinions expressed during last Friday's discussion which had a real bearing on the subject of the paper, the majority were cautiously non-commital or politely agnostic. One speaker, it is true, used the paper as a peg on which to hang a picture of revolutionary developments in our knowledge concerning, and methods of using, steel. For the most part, however, the discussion added little of any value to the substance of the paper, and at times took a turn which was slightly hostile to the authors' views. One of the most striking, and, it may possibly be found, one of the most fundamentally significant observations made by Mr. Robinson was to the effect that if a steel has the right macrostructure to begin with subsequent manipulation and heat treatment will not affect its machinability; but if the steel is bad in the ingot state, it is inherently bad, and no amount of normalising or other treatment subsequently will put it right. On that subject more than one speaker quoted evidence to the contrary. The President, for example, stated that machining difficulties similar to those detailed by the authors had within his own experience been satisfactorily overcome by raising the steel to a dull red heat and then, when all the visible heat had disappeared, quenching it in water. Had this lead from Mr. Taylor been followed up in a proper manner, a useful contribution to the discussion would doubtlessly have been forthcoming. As it was, subsequent speakers did little more than repeat the President's observation, with the result that the point, involving, it would seem, a direct clash of evidence, was left hanging in the air. The metallurgists, if any were present, preserved complete silence. Yet it was clearly an opportunity for them to come to the engineers' assistance. Mr. Robinson, as an engineer, expressed no opinion as to why a steel showing a particular type of etched band structure should possess good machining qualities. He was concerned merely to advance evidence to show that the criterion was a sound one, and did not attempt to offer any explanation of *why* the banded structure provided a criterion of machinability. One speaker alone seemed to come within range of this aspect of the question when he asserted that the banded structure was caused by the presence of phosphide lines in the steel. Mr. Robinson, however, readily demolished that argument. Banded structures, he said, had been revealed by specimens of Armco iron, a material which contained no phosphorus and had not been produced on certain steels containing as much as 0·1 per cent. of phosphorus. The real source of the difference in the machinability of different supplies of ostensibly similar steels and, therefore, the real source of the difference in their macrostructures as revealed on etching lies, Mr. Robinson is certain, in the manner in which the ingots are handled at the steel works. Careless handling during the cooling stage gives, he asserts, a steel which will machine badly and show a defective macrostructure. Prolonged soaking and slow cooling produce a material which, even after subsequent rolling, forging and heat treatment, will machine satisfactorily. Mr. Robinson's statement of the case throws practically the whole of the onus for the achievement of good machinability on to the steel maker. Yet there is plenty of evidence, as we have noted, to the effect that after the steel maker has done his best, or his worst, with the material, the engineer can, by a heat treatment process, change an almost unmachinable steel into one which machines satisfactorily. Unless we are prepared to write down the prolonged and careful investigation at Enfield as misleading, we have here a paradox which the metallurgist might attempt to reconcile to the great benefit of the engineer and the steel maker.

The paper has served once again to emphasise the fact that the machinability of a steel is not to be judged solely by physical properties, such as tensile strength or Brinell hardness, or by its chemical composition. Whether, however, Mr. Robinson is correct in identifying a particular form of etched structure with good machinability, and, if so, why the fact that the steel reveals such a structure should give it good machining qualities, can only be settled by much farther research of an engineering and metallurgical character. We welcome Mr. Taylor's suggestion that the subject should be investigated by a research committee of the Institution. It is of vital importance that engineers should be put in possession of a trustworthy and easily applied means of judging the machinability of the metals—ferrous and non-ferrous—which they employ, and that they should be enlightened as to the fundamental properties which impart machinability. There are many points to be resolved. Some of them, for example the applicability of Mr. Robinson's criterion as a means of judging the machining qualities of the non-ferrous metals, might be illuminated by a really satisfactory discussion, at which all the talent and knowledge of the members of the Institution were united. Last Friday's meeting illustrates very markedly the disadvantage under which the Institution suffers by reason of the dispersion of its debating forces. The discussion was unsatisfactory, incomplete, and of little real value, because many of those who could have contributed usefully to it preferred, we can but presume, to reserve their remarks for the meeting of their local branch. It may be that in the end the various discussions as presented in the "Proceedings" will together cover all the ground, but they will do so with a very considerable amount of useless repetition and without the inspiration which would have come from a union of forces. Not only are the London meetings of the Institution suffering because of the partiality of local members for their own branches; last Friday's experience convinces us that the scientific value of the Institution's debates is being lessened by the dispersal of the discussions on its papers over several centres. The desirability of periodical "plenary" meetings of a purely technical nature is made more than ever pronounced by the disappointments of Friday last.

Prove All Things.

IT may be convenient to divide research into two main groups—Micro-research and Macro-research. The mere names are almost adequate definitions. Micro-research is that kind which peers into the minutiæ of materials and processes; macro-research concerns itself with materials and processes in bulk. Bearing metals present an example. The micro-researcher studies the crystalline, molecular and atomic structure of the metals; the maker of bearing alloys combines his materials in various proportions until he finds a mixture which gives satisfactory results. Edison's hunt for a fibre for the filaments of carbon lamps is another example. He sent men scouring the world for fibrous materials and tested them by the hundreds. That was his method throughout his life. Swan's invention of the cellulose filament was more scientific. He did not prove all things to find what he needed, but applied his chemical knowledge to the production of an artificial thread which could be readily carbonised. In the sense that he knew that the atomic structure and chemical nature of cellulose rendered it suitable for carbonisation into lamp filaments he was amongst the micro-researchers, whilst Edison, plunging into a lucky bag, almost at random, must be placed amongst the macro-researchers. Mr. Robinson's investigation of the machinability of steel having a banded structure, which we discuss above, is a recent excellent example of macro-research.

It is, we suggest, a mistake to look upon scientific or micro-research as invariably more important than macro-research. A vast amount of progress is due to the latter; the history of engineering and technology is founded upon discoveries made by trying things. Most of our industrial processes are the outcome of methods of discovery no more scientific than culinary cooking. Serviceable metals were produced ages before Stead turned the microscope upon their structure; steel was hardened before the effect of carbon upon iron was understood, and non-ferrous alloys were multiplied before the equilibrium diagram was devised. The steam engine had advanced far before thermodynamics became a science, and the steam turbine was produced by trying rather than by the application of science. In fact, science, like mathematics, has, in the majority of cases, followed rather than preceded discoveries; it has shown us what we were doing and why we got certain results, and in that way has helped progress enormously by explaining limitations and directing us to further developments. But it does not open the only road to further discoveries, and it may be hoped that a large modicum of blundering people who

are prepared to test even the most unlikely things by actual experiment will always remain with us—men like Giffard, of the injector, or Wilde, of the self-exciting dynamo. Some interesting examples are presented in an article which appears in the current number of our monthly Supplement —*The Metallurgist*. In it experiments with very improbable materials for bearings under heavy loads are described. The use of *lignum vitæ* we may dismiss as its properties have been known for generations, but who would have thought of bakelite as a suitable substance for the bearings of a rolling mill, or, still more wonderful, of soft rubber for the same duty? Yet both of them have shown promising results. We recently heard of synthetic resin being employed for a service for which, owing to the temperatures involved, the makers held it to be unsuitable. Fortunately, the inquirer decided to try it in face of their *caveat*. His temerity was justified. For the duty required it proved better than any of the more likely materials which had previously been employed, and overcame a great difficulty. It is not only in the materials of technology and engineering that the macro-researcher may divide the honours with his more scientific brother. In machines themselves he finds even greater scope for boldness of imagination, scepticism with regard to many things that everybody believes, and a readiness for adventures. It has been truly said that no one knows if a novel mechanical device will work until it has been tried. The converse is also very often true; no one knows that a thing wont work till he has tested it. And the great advantage of trying, even the improbable, is that it may lead to something unexpectedly good. Many of our readers will recall the early history of a now famous fan. It was designed on certain lines which departed from the normal, and, in the early stages of the experiments, some of its numerous blades broke. The observant inventor noted a slight improvement, so he cut down all the blades. Again he narrowed them, and again, until he found the optimum width, which was many times less than he had anticipated. No doubt the same result could have been attained by scientific reasoning, but it is always easy to be wise after the event and, in many cases, the world might be waiting still for a scientist to get an idea whilst the engineer might blunder upon achievement by doing something. It is best to do what is right in the light of science, but it is better to do even what is wrong than to do nothing at all. The engineer's road to success is paved with failures.

We sometimes fear that education and training tend to discourage the adventurous spirit. The student is taught to place his reliance in science and as, too frequently, he lacks an imagination which can leap outside the bounds of the curriculum, he condemns everything that does not fall within his rather limited scope. In the workshop and factory he sees things done in certain prescribed ways, and he comes to think that those are the only ways of doing them. Scepticism is as unwelcome in the workshop as in the college, and the imagination which is inherent in all young men is discouraged. Here and there a few break away from traditional science and traditional technology. They desire to prove all things for themselves, to put them to the test, and out of their daring adventures spring new inventions. Great and wonderful as properly ordered scientific research is, let us not forget that the man who is prepared to try the improbable, or, at least, the unknown, may also serve his generation.

Obituary.

HERBERT CARPMAEL.

IT is with profound regret that we have to announce the death, on Sunday last, of Mr. Herbert Carpmael, who for over thirty-three years was a valued member of the Editorial Staff of this paper, and for the larger part of that time was Chief Sub-Editor. He came of that family of Carpmaels who founded the famous firm of patent agents that still bears their name, and he inherited, no doubt, from his uncles the engineering instinct. After a private education he was sent to Dulwich College, and to the very last preserved a warm affection for his old school. There he distinguished himself as a rifle shot, and for many years, both as a shot and as a coach, was a familiar figure on the public school days at Bisley.

He left Dulwich in 1887, when electrical engineering was showing the early signs of its great future, and went into the Brush Company's works in London, where he served his apprenticeship, gaining experience both in the shops and in power stations. In 1890, when his studentship ended, he was appointed assistant engineer, and in the following year chief assistant in the testing department of the firm. In 1893 he was for a few months in charge of the municipal electric lighting at Blackpool, but in August of the same year joined Messrs. Bramwell and Harris in Westminster, and was engaged in both civil and electrical work for them. Amongst the experiences to which he looked back were those on the French railways during experiments, lasting six months, on the electric lighting of trains, which he carried out for the Brush Company.

In 1897 THE ENGINEER instituted a series of motor car trials, the judges being Sir Frederick Bramwell and Sir John Aspinall. Mr. Carpmael attended these trials as one of Sir Frederick's staff and thus made his first contact with this paper. In the following year, extension of the Editorial Staff having become necessary, he was invited to join it, and in October of that year, 1898, he was appointed one of the assistants to the late Mr. Vaughan Pendred. In course of time he specialised in civil engineering, particularly in water supply and sewage disposal, and attended to that class of work whilst acting as Chief Sub-Editor. Whilst he had a good knowledge of the water supply of the United Kingdom as a whole, of Europe, and even of the American continent, his familiarity with that of the Metropolis was not only technically complete, but extended deep into history.

For many years his health had been far from satisfactory, but he remained, nevertheless, an extremely hard worker and no company ever had a more loyal servant. A man of deep sympathy, particularly with

HERBERT CARPMAEL

those in distress and difficulty, he made many friends, and his loss will not only be deplored by the staff of this paper, of whom everyone is his debtor for some kindness, but by many whom he met in the pursuit of his work. We must mention, too, his old schoolfellows, for his devotion to Dulwich never left him. He retained to the end something of the heart of the schoolboy and followed with the keenness of youth the progress of the younger generation. He leaves behind him a deep feeling of affection, tinctured with sadness for the long years of ill-health which he had to endure. He was childless, but we desire to express to his wife who survives him our great sympathy with her in her grievous loss.

He was born on July 6th, 1868, was elected an associate member of the Institution of Civil Engineers in 1897, and an associate member of the Institution of Electrical Engineers in 1902.

Literature.

Applied Personnel Administration. By J. E. WATERS. London: Chapman and Hall, Ltd. 1931. Price 18s. 6d. net.

ALTHOUGH the subject of *personnel* administration is probably one that has received the least serious thought in connection with post-war industrial reorganisations, it is nevertheless a very important one; but it is doubtful whether many British engineers would feel justified in setting up a department as elaborate as that so clearly sketched out in "Applied Personnel Administration." The information collected by the author is based upon thorough investigations, coupled with visits to the *personnel* departments of seventy-five industrial and business concerns of varying magnitude, amplified by his own personal experience. The work is frankly written from the American standpoint, and the selected references at the end of each chapter, compiled with commendable care, direct the reader almost exclusively to American literature.

The book is divided into seven distinct parts, each dealing with a broad section of the subject, and subdivided into chapters as required. Part I. introduces the main theme, and gives as the reason for *personnel* administration that by increasing production through improved human efficiency it pays for itself in cents and dollars, while it also increases happiness among employees. The classification of employee development is by means of four groups—mental, physical, moral, and social—and the means of measurement and methods of development are tabulated. The lay-out of the department under an efficient *personnel* director is formidable enough, with its medical director, its safety director, its employment manager, and its director of training; but in "small plants, employing from five hundred to a thousand," the author suggests that "the employment manager, with some assistance, may take charge of the work."

In Part II. the various problems connected with recruitment, promotion, discharge, &c., are carefully considered. While we agree that "efficient selection of employees increases human efficiency as well as eliminates labour turn-over," we are not so convinced that the best type will be secured as a result of the elaborate tests and examinations, questionings and interviews to which the author would apparently subject the applicant. Plans for systematic promotion are all to the good, and two are described, one called the "three-position plan," which visualises a man, not only in his present position, but as a trainer of the man immediately below him, and also as a student of the one next above him in the organisation. In the other, the "multiple-chain promotion plan," the man is considered as a link in a multiple chain, and in relation to all the other links. Too often promotion is haphazard.

Part III., the longest in the book, occupies 117 pages —or seven chapters—and deals with *personnel* maintenance, including the question of wages, job analysis, ratings, and the relations of employer and employed. This section, useful in its way, is chiefly concerned with matters that are more generally known and appreciated by engineers. When we read the suggestions regarding the records that should be kept and the detailed statistics that must be compiled, we visualise a regular army of clerks in the *personnel* department, all thoroughly conversant with everyone else's business, even to their religion and recreations, and we begin to wonder whether "the game is worth the candle."

We turn with a certain measure of relief to Part IV., for here we find eminently practical proposals as to industrial training and education, which British manufacturers might peruse with profit. The idea of instructing foremen in efficiency and development with promotion in view is a very sound one, and it is certainly desirable that management and education should work hand in hand. We are informed that "some of the larger companies have a regular policy of taking the grammar school graduates for skilled workmen, bosses, and sub-foremen; high school graduates for foremen and supervisors; and college graduates for executives." We should like to know whether such a practice has justified itself, for it sounds distinctly arbitrary.

On turning to the subject of Industrial Health (Part V.), we are not surprised to learn that in those factories where health work has been introduced absence losses have been considerably reduced, but when we glance at the organisation chart of the health department, its very magnitude seems to indicate a measure of the cost of that gain in working hours. Does it really pay for itself? In the absence of a balance sheet we may be pardoned if we remain somewhat dubious.

Considerations of Safety (Part VI.) are essential, and can hardly be reduced to terms of profit and loss. The steps proposed to be taken to interest foremen in this side of the works' activity can be warmly endorsed. Instead of endeavouring to keep accidents to a minimum, the present-day aim lies in the direction of their prevention. The success of this movement is clearly demonstrated by a table showing the percentage accident reduction in fifteen representative companies, of which the highest is as much as 90 per cent. and the lowest 23 per cent.

Under the caption "Employee Service Work" (Part VII.) we soon recognise what was formerly known as "welfare work," an activity which was looked on askance, as tending to destroy the liberty of the individual and force on him something for which he would eventually pay, even if indirectly. But there are many ways in which a firm can genuinely render "service" without being stigmatised as "paternal."

The review summary at the end of each chapter will prove very helpful, and if a few of the suggested tests are applied to the heads of some organisations the results might be found to be somewhat chastening.

We can only give a very limited idea of the field covered by this book, which we have read with much interest, and even if we are not prepared to advocate the adoption of the complete scheme as propounded, this must not be taken as any reflection on Mr. Waters' proposals, but rather as an indication that

the conditions in this country are not strictly analogous to those obtaining in the States. The book justifies careful perusal, and no manufacturer or engineer is likely to read it without gaining some useful ideas that might be applied to the organisation for which he is responsible.

Land Ho! By E. C. BOWDEN SMITH. London: Simpkin Marshall, Ltd. 1931. Price 5s.

IN this volume the author has given us two essays worthy to take a high place in the literature of the sea. The first is entitled "The Last of Her Race," and the second "The Convoy."

The last of her race was the sailing ship "Torrens," a full-rigged composite passenger clipper, built for the Australian trade to the order of Captain Henry Robert Angel, the principal owner, who was born in 1829 and died at sea in 1923. She was laid down in the Deptford Yard of James Laing, at Sunderland, in 1875, and in the same year left Plymouth on her first trip to Australia. From then onwards for fifteen years no ship approached her average speed from London to Port Adelaide. "She ran her easting down, where the strong fair winds of Heaven always blow, and she touches sixteen knots by the log, running free before the gale, the rollers towering high above her stern." The Angels sailed her. She had wonderful lines and, like a ghost, slid quietly through dead seas when other vessels lay becalmed. She was only 221ft. in length. Her beam was 38·1ft. her depth 21·55ft., and she was rigged after the "Cutty Sark." In the "Roaring Forties" she made her 300 to 350 miles a day without shipping a sea, "though the seas towered astern high above the poop, so close it looked as if you could touch them with a boat hook. . . . She could beat across the Bay when steamers had to slow their engines and lie to. She could wing her way across the tropics when other ships would lie almost becalmed. . . . She could tack through the Backstairs Passage careering like a yacht to the off shore breeze. . . . She broke the record in sixty-four days on the great trade route to Australia. . . . Every twelve months she turned up in Port Adelaide with the regularity of the seasons, and the history of the Colonies could be traced from her records." In the hands of the Angels, father and son, the "Torrens" sailed without serious mishap, but with a stranger in command she was dismasted by a sudden squall on a calm day; the story of that accident is admirably told in the essay. Mr. Bowden Smith sailed out of London in the "Torrens" in October, 1896, and in the long voyage learnt to know and love her, and to love the element on which she moved. "Romance there may be in plenty," he writes, "for those who go down to the sea in ships, and admiration we all have for the iron-walled hotels that science sends hurtling through the seas in a bee-line from port to port as with remorseless energy and power they ignore the elements, but the glory of conquest, the thrill of victorious achievement in mastering the mighty winds and seas that sweep the globe remains for ever with the clippers and their captains who sailed the 'Roaring Forties' at 300 miles a day."

But in the end the splendid little ship went down to the steamer. Freights failed her, and in 1906 she was sold to the Italians for £1500 and broken up a few years later in Genoa.

We turn from Mr. Bowden Smith's delightful biography of a personality which belongs to a dead period to a very different picture. We are in the last of the war years, when all the devices of art and science had been evoked to counter the "U" boats and the convoy system with its fleet of camouflaged vessels with plodding "K" boats on its wings and busy destroyers watching over it like sheep dogs with a flock was evolved.

In 1918 the author desired to sail from Port Said to England. He describes in lively language his efforts to get a passage, the extraordinary secrecy that surrounded the movement of ships from the port, and the furtive way in which, at length, with the password War-ah-Moor, he found a passage in a large freighter which formed part of a convoy.

The fleet slipped out on a sunny morning. "First a thin sloop, in pale gray with slender masts," then two destroyers, "the acrobats of the fleet," then six "K" boats, "like harlequins in striped pantaloons," which some call double-ended trawlers, as even their own commanders cannot tell at a distance which end is the stem and which the stern. The main fleet, with paravanes unshipped ready for immersion, followed. "Each vessel had her appointed speed and her appointed place, and they all surged forward as a single ship."

Mr. Bowden Smith gives an admirably lucid description of the handling of a convoy and the Einsteinian means by which the watchful "U" boat was deceived. On the wings were the "K" boats, double-ended, moving at a constant speed. Inside were the vessels of the convoy in two lines, continually changing speed by the orders of the flag ship. Thus the periscope saw the convoy through the wall of "K" boats. But it had no means of telling which way the latter were heading, and the alternating speed of the background—the vessels of the convoy—sometimes made the "K" boats seem to advance in one direction and sometimes in the other—a fine example of relativity. On top of this confusion of speed and direction there was confusion of substance. The vessels, ingeniously camouflaged, seemed continually to change their shape. Now two or three would apparently combine till they looked like a many-funneled liner; now they were separate and disappeared in a haze of colours. And so the fleet in fancy dress, "masquerading across the high seas, confounded the hostile submarine and all his devilish tricks," and after stirring adventures came safe and sound to England.

Electric Train-Lighting Theory and Practice. By C. COPPOCK. London: Sir Isaac Pitman and Sons, Ltd. Price 7s. 6d.

ORIGINALLY published for the most part as a series of articles in the *Railway Engineer*, this book deals with the leading systems of train lighting by means of electricity. In the absence of a third rail or overhead conductor there are three principal methods by which the necessary lighting current can be obtained, and in his introduction the author discusses the merits and demerits of these methods. The first is what is known as the straight storage system, in which each coach is fitted with a battery which is charged at the terminus, a method which, on account of its obvious disadvantages and its limited application, calls for little comment. The second method, which has been more widely adopted, particularly in the United States, is the "Head-on" method, in which the current for the lighting of a train as a whole is supplied from a special car equipped with a generating unit, usually in the form of a steam turbine-driven generator supplied with steam from the locomotive. But for this system to be a success it is necessary to regard the train as an indivisible unit, and when trains have to be frequently split up for branch line working it adds greatly to the difficulties of traffic control. The book, therefore, deals with the system now almost universally adopted, namely, that in which each coach is equipped with lighting plant as an independent unit and in which current for the lamps and accumulators is supplied by a dynamo slung underneath the coach and driven off the axle.

As the voltage of a dynamo increases with its speed, this method, in which the dynamo is driven from an axle pulley, has given rise to various methods of regulating the voltage. The first and simplest method considered is that of allowing the belt to slip on the dynamo pulley when the maximum full load torque has been reached. As the train speed increases from this point the dynamo speed remains constant, and for this reason this method of control is called the constant speed system to distinguish it from the free speed system, in which the speed of the dynamo follows the speed of the train. The free speed machines, which run with a tight belt, depend for their regulating properties on the fact that when the armature conductors of a generator carry current the magnetic field set up by them can be made to weaken the main field either by distortion or direct opposition. In dealing with dynamos for train lighting, interest mainly centres on those machines which are called self-regulating, for those in which output control is brought about by means of slipping belts or external regulators are substantially plain shunt machines, differing little from ordinary machines of that type, except by the additional means whereby their polarity is maintained constant irrespective of the direction of rotation. To these self-regulating dynamos the author devotes considerable attention. All free speed systems regulate by weakening the field of the dynamo as the speed increases, but in some cases the means of regulation are inherent in the machine itself, whilst in others it is provided by external regulators. To these regulators the author also gives attention, and solenoid-operated, motor-operated, and vibratory regulators are described in a general way.

Briefly put, all the train lighting systems that count are described. Two chapters are devoted to storage batteries, one to lead acid batteries, and the other to alkaline batteries of various makes. A chapter on fundamental problems sums up the main problems associated with the subject in a clear and simple way. Although the book contains a good deal of descriptive matter based no doubt on information supplied by manufacturers, the author appears to have a good general knowledge of the subject, and his comments on the different lighting systems, &c., make interesting and instructive reading.

SHORT NOTICES.

Roget's Dictionary of Electrical Terms. By S. R. Roget. London: Sir Isaac Pitman and Sons, Ltd. Price 7s. 6d.—In preparing this second edition of his "Dictionary of Electrical Terms," Mr. Roget has endeavoured to steer a middle course between incompleteness and a redundancy which would defeat the objects of the work by inconvenient bulk and clumsiness in use. Hence even where the subject-matter tends to interlock considerably with neighbouring branches of science or practice, the electrical side of the boundary has been adhered to. The word "condenser," for instance, is dealt with only in its electrical sense, and no mention is made of the fact that it also refers to a vessel in which steam is turned into water. The central station engineer will find that the Dictionary will only be of assistance to him in connection with the electrical side of his station; nor does it cover purely mechanical features of electrical machinery or the mechanical contrivances associated with electric railways. Many special terms in railway signalling not inherently electrical have been omitted; but, on the other hand, in the case of general physical units a greater latitude has been observed. As a general rule, purely trade names of apparatus have been left alone, except in certain cases where they are so intimately associated with apparatus as to amount practically to technical terms. The range covered embraces electric light, power and traction, telegraphy and telephony, including "wireless," and the other miscellaneous applications in some detail as well as the general science of electricity and magnetism without proceeding too far into its ramifications in the directions of pure physics and chemistry. It has been impossible, Mr. Roget states, to make any hard-and-fast distinction as to Americanisms. Many terms are confined almost entirely to the United States, and there are more which originated there and are now in equally common use on both sides of the Atlantic. Thus, in order that the work may be of use to the English reader of American technical literature, as well as to the American reader of English works, explanations are given of both classes of expressions, without any attempt to classify them. The use of several terms for the same thing, such as wattless and blind current, for instance, is a source of nuisance and ought to be abolished.

Causes and Cures of Unemployment. By Sir W. H. Beveridge, K.C.B. London: Longmans, Green and Co. 1931. Price 2s. 6d.—In this volume are reprinted in a convenient form six wireless talks on Unemployment which the author broadcast last year. In view of its origin, it is, of course, rather elementary, but in consideration of Sir William's wide knowledge of industrial matters, it is worth reading. He points out that Unemployment is not a disease of society, but a symptom of one or more different diseases. One of these diseases is our failure to control credit, and until and unless we learn how to do that, periodical slumps will occur. Another is the "administrative factor," which means the effect of insurance. "It relaxes both social effort and individual effort for the prevention of unemployment," and tends to perpetuate disorganisation of the labour market. Yet another is related to the "general economic condition." "It is declining prosperity that takes the form of unemployment, because it is not allowed to take the form of lowered wages and standards of living." The cure for this last disease is, in Sir William's opinion, not the lowering of the standard of life, but lowering costs by increased productivity. With that view, all engineers at least, are in accord. The difficulty lies in the fact that we cannot hope to increase our productivity beyond that of our competitors and the margin of lower wages will tip the beam in their favour.

Eureka: An Essay in Economics. By R. M. Seddon. Glasgow: The Political Bookshop. 1931. Price 2s.—*Ordeal by Banking: The Test of a Constructive Policy.* By W. Allen Young. London: Cecil Palmer. 1931. Price 2s.—In the first of the two books named above the author develops a proposition that, by steps so gradual that no one would be wronged, all personal property shall be withdrawn from the field of trade or commerce, "leaving the field to Capital, which will then receive, direct, the rent and interest which is its due." The scheme would be completed by the end of the present millenium, and with the opening of the year 2001 the private capitalist would cease to exist and the income of all would be derived from their labours and their labours alone. The second book takes up the precisely opposite standpoint. Adopting Major Douglas' principles, Mr. Young desires to see the national credit employed to finance a reduction of prices, "and to provide dividends out of the increased output thereby stimulated." Whilst Major Douglas' interesting proposals are a subject rather for business experts than for technical engineers, we admit that if we were called upon to judge between these two rival plans for increasing the welfare of the world, we would lean rather to his than to that of Mr. Seddon.

BOOKS RECEIVED.

Metal Aircraft Construction. By M. Longley. London: Gale and Polden, Ltd., 2, Amen-corner, E.C. 4. Price 15s. net.

Advanced Mechanics of Materials. By F. B. Seely. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 31s. net.

Sell's Directory of Registered Telegraphic Addresses, 1932. London: Business Dictionaries, Ltd., 8 and 9, Johnson's-court, E.C. 4. Price 45s. net.

The Water Engineers' Handbook and Directory, 1932. London: The *Colliery Guardian* Company, Ltd., 30, Furnival-street, E.C. 4. Price 8s. 6d. net.

The Competitive Position of Coal in the United States. New York: National Industrial Conference Board, Inc. 247, Park-avenue, N.Y., U.S.A. Price 3 dollars net.

Foundry Work and Metallurgy. Volume III. Edited by R. T. Rolfe, F.I.C. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. net.

The Theory and Design of Structures. Fifth edition. By E. S. Andrews, B.Sc., &c. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 1. Price 13s. 6d. net.

Symposium on Effect of Temperature on the Properties of Metals. New York: American Society of Mechanical Engineers, 29, West 39th-street, N.Y., U.S.A. Price 6 dollars.

Collected Reports on British High-speed Aircraft for the 1927 Schneider Trophy Contest. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price £1 net.

Experimental Electrical Engineering. By E. T. A. Rapson, A.C.G.I., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 3s. 6d. net.

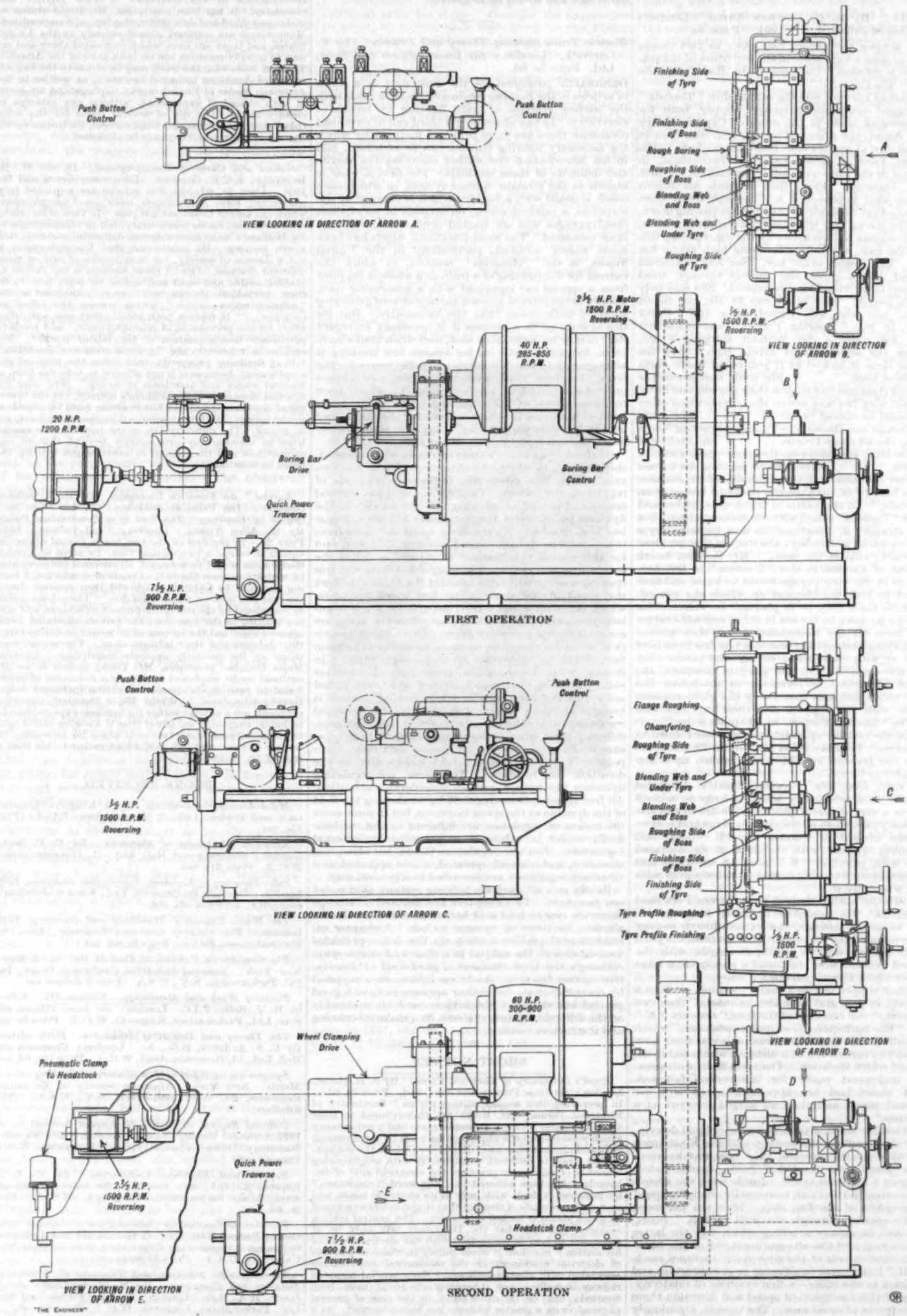
Tests on the Continuous Carbonisation of Finely Crushed Coal by Radiant Heat. By F. B. Hobart and D. J. Demorest. Columbus: Engineering Experiment Station, Ohio State University, U.S.A. Price 50 cents net.

The Scientific Selection and Training of Workers in Industry and Commerce. By M. Martin-Leake and T. Smith, M.A., B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 5s. net.

RAILWAY CARRIAGE AND WAGON WHEEL TURNING PLANT

CRAVEN BROTHERS (MANCHESTER), LTD., REDDISH, ENGINEERS

(For description see opposite page.)



"THE ENGINEER"

Railway Carriage and Wagon Wheel Turning Plant.

We recently had an opportunity of inspecting a remarkably efficient plant for performing the whole of the turning operations on solid disc railway carriage and wagon wheels which has been designed and built by Craven Brothers (Manchester), Ltd., Reddish, near Stockport, to the order of Taylor Brothers and Co., Ltd., Trafford Park. The complete plant embraces two lathes arranged side by side, as shown in Fig. 1, page 342. Fig. 2 is a larger view of the first operation machine, showing the general design of the headstock and the pneumatic clamp, the covered bed and the boring bar feed. Fig. 3 is a similar view of the second operation machine, showing, amongst other features, the hand wheel in the foreground, which controls the flange roughing and chamfering tools. Fig. 4 shows the first operation machine, with ammeters, tachometer and the general arrangement of the controls. The drawings, on page 346, show the tooling lay-out for both machines, while Figs. 5 and 6 are time charts giving the exact sequence of operations.

The railway wheels are brought from the presses to the left-hand side of the machines, and are stored in the vertical position ready for mounting on the first operation machine. An overhead gantry—not shown—fitted with three electric hoisting blocks, operated by pendant push-button control, is provided to lift the wheels into the first machine, to lift them out of this machine into the second machine, and finally to remove the finished wheel to the clearing position. By this procedure a continuous flow of operations is maintained, and the whole of the turning work on a wheel is completed in ten minutes, or six per hour, leaving only the sizing of the bores to be done. The wheel to be turned enters the machine shown on the left-hand side of Fig. 1, called, for convenience of reference, the first operation machine. In this machine the wheel is gripped in a concentric chuck and the outer face of the tread and boss is turned, the hole is rough-bored, and the boss and inside of the rim are "radiused." If required the boss and rim may also be blended into the web on this machine.

After the first machining operations have been performed, the wheel is removed as described above to the second machine, in which—in the reversed position—it is located by its bore, while the tread and flanges are rough and finish turned, the rim and the boss faced, the inside of the rim and the boss radiused, and finally, if necessary, the web blended into the rim and boss.

Owing to the large amount of metal which is removed in these operations, special arrangements are made to clear the cuttings. For this purpose a conveyor belt is provided under the bed chutes. The belt is 24in. wide, has a surface speed of 88ft. per minute, and carries the cuttings out to a trolley arranged in the foundations. This trolley can be run clear of the machines and hoisted up for emptying. It has a perforated bottom to allow the cutting compound to run back into a tank beneath. The water supply for both machines is derived from one pump, which draws its supply from the tank in the foundation, and is capable of dealing with 5000 gallons per hour against a total head of 15ft.

The time charts, Figs. 5 and 6, for the first and second series of operations, show clearly the time occupied on each, the speeds and the feeds. As will be seen the high output obtained is to be ascribed in large measure to the performance of several operations smultaneously, as shown by the thick black lines.

Having now given a rough idea of the general arrangement of this interesting plant, we shall proceed to describe the chief features of the machines in detail. The headstocks are arranged to traverse up to positive stops, while the tools are carried on saddles mounted on a stationary cross bed, which is rigidly attached to the main bed. The traverse is effected by a 7½ horse-power reversing electric motor, driving a screw which quickly runs the headstock into or away from its working position, as required. Incidentally, it should be mentioned that the bed is protected by covering slips. The headstock spindles are of large diameter and run in adjustable capped phosphor bronze bearings. The reduction gears from the main driving motor to the face plate are of steel and are totally enclosed in oil bath compartments in the main casting. All the gear wheels, as well as the main and auxiliary bearings and shafts, are mechanically lubricated by a built-in pump, and the oil may be seen circulating through the system by means of inspection windows in the cover plates. A pressure gauge is also fitted on the output side of the oiling system to show at a glance whether the pump is doing its full work.

The headstocks are locked to the bed in the working position by pneumatic clamps of the self-locking type, controlled by a lever fitted to the front of the machine and convenient for access. The face plates revolve inside substantial guards, which protect the driving ring teeth from damage and exclude dirt. The pinions which drive the face plates are carried in bearings on both sides. The first operation machine has a hollow main spindle, through which is passed a boring bar of large diameter carried in self-lubricating bearings provided with washers and wipers to exclude grit, &c. The bar has a detachable double-tool cutter head, and is arranged to rotate in the opposite direction to the face plate. If desired, it may be held stationary and the face plate rotated around it. The boring bar drive and feed gear form a separate unit attached to the rear of the headstock and driven by a 20 horse-power motor through worm reduction gearing. The quick return movement of the bar is provided with pneumatic control, which disengages the feed clutch and engages a fast-running friction clutch for withdrawal. The control for the operation of the pneumatic clutch is situated on the saddle in a convenient position, and there is an auto-trip in the outmost position. The feed of the bar is obtained through a stationary screw and revolving nut, the screw being seen in Fig. 2, which also shows the automatic trip rod for the quick withdrawal clutch. A copious supply of water is arranged to flow through the bar and impinge directly on the tool noses when boring is in progress.

The wheel to be turned is held in concentric chuck jaws, which grip the tire tread in such a manner that the inside face of the wheel is brought hard up against a positive face and runs true, without any setting being necessary. The chuck jaws are power-operated by a rotating cam ring built into the face plate and revolved by worm reduction gear by a small electric motor, also attached to the face plate, which picks up its supply of current through collector rings and brushes on the main spindle. In operating the machine the railway wheel is first gripped in the concentric jaws and the headstock is run up to the working position, where it is locked by the pneumatic clamps. The various cutting tools for facing and radiusing are applied from the saddles on the cross bed, while simultaneously the boring bar operates from the back for rough-boring the hole. After the operations in the first machine are finished, the wheel is turned round and transferred to the second machine, where it is located by its bore. The locating mechanism consists of a steel bar passing through the spindle and fitted with hardened steel serrated grips which are adjusted up to the bore by hand. When the grip pieces are in contact with the bore, the locating bar is drawn back by power causing the grips to slide up an incline and obtain a firm hold, at the same time pulling the wheel back on to a solid backing given by three distance pieces secured to the face plate.

The wheel is driven by Craven's three-point compensating driver, which consists of three radial jaw slides operated by a loose floating cam ring, having hardened steel serrated pads to grip the underside of the tire rim and slide up inclines against the pressure of the cut. The movement of these pads is limited by stops to prevent excessive bite on the drivers, and the three jaws are actuated collectively by rotating the cam ring by means of a "tommy" bar. On both machines the feed to the saddles and tool slides is obtained through a shaft driven by gearing from the face plate pinion, and the quick return of the tool slides is effected by independent reversing electric motors. All the controls are grouped for ease of operation, the push-buttons being mounted on standards on the saddles. The main motors are similarly controlled and have "stop," "start," "inch," "accelerate" and "retard" motions while a pendant switch is used for the traverse and chuck control.

The following are the leading dimensions and particulars of the machines :—

Height of centres	3ft. 9in.
Spindle neck front diameter	20in.
Spindle neck back diameter	11in.
Spindle speeds	1 to 10 r.p.m.
Boring bar speed, first machine	20 r.p.m.
Boring bar feed, first machine	3/32in. per rev.
Boring bar motor, first machine	20 horse-power
Main drive motor, first machine	40 horse-power
Main drive motor, second machine	60 horse-power

SECOND OPERATION

	Operations	Revolutions per Minute.	Start / 3 R.P.M. / Slow / 1½ R.P.M. / Stop	Times per Oper.	Total Times
		Times.		Min. Sec.	Min. Sec.
1	Pick Up Wheel and Thread on to Internal Chuck	Feeds.		10	10
2	Pull Back Wheel by Power against Locating Pads	Power.		10	10
3	Adjust Cam Drivers under Rim			10	10
4	Traverse Headstock Forward and Clamp	Power.		10	10
5	Engage Feed for Rough Turning Tread and Traverse	1/8		5 0	5 0
6	Engage Feed for Rough Facing Rim and Boss and Traverse	5/32		5 0	30
7	Rough Form Tread, Chamfer Flange and Withdraw Slide	Hand		5 0	—
8	Traverse Tread Turning Slide to Forming Position			10	—
9	Finish Form Tread	Hand		2 30	2 30
10	Finish Face Boss and Rim and Radius Corners	Hand		2 30	10
11	Withdraw Facing and Radiusing Tools	Hand		10	10
12	Withdraw Tread Turning Slide	Power.		10	10
13	Withdraw Roughing Slide	Power		10	10
14	Unlock Headstock and Traverse Back	Power		10	10
15	Attach Lifting Hook and Release Internal Chuck	Power		2	20
16	Remove Wheel			10	10
				Total 10 0	

"The Engineer"

FIG. 6—TIME CHART FOR SECOND OPERATION MACHINE

FIRST OPERATION

	Operations.	Revolutions of Faceplate per Minute.	Start / 3 R.P.M. / Slow / 1½ R.P.M. / Stop	Times per Oper.	Total Times
		Times.	1 2 3 4 5 6 7 8 9 10	Min. Sec.	Min. Sec.
1	Lift Wheel and Place in Jaws.	Feeds.		15	15
2	Tighten Jaws.	Power.		5	5
3	Traverse Headstock Forward and Clamp	Power.		10	10
4	Engage Feed to Boring Bar and Traverse. Speed 20 R.P.M.	3/32"		5 0	5 10
5	Engage Feed for Rough Facing Rim and Boss	1/8"		5 0	30
6	Return Boring Bar	Power		10	—
7	Finish Face Boss and Rim and Radius Corners	Hand		2 30	2 35
8	Withdraw Facing and Radiusing Tools	Hand		10	10
9	Return Roughing Slide	Power		10	15
10	Unlock Headstock and Traverse Back	Power.		10	20
11	Attach Lifting Hook and Release Jaws			10	20
12	Remove Wheel			10	10
				Total 10 0	

"The Engineer"

FIG. 5—TIME CHART FOR FIRST OPERATION MACHINE

THE WHITWORTH SOCIETY.—The ninth annual commemoration dinner of the Whitworth Society was held at the Holborn Restaurant on Friday, the 18th inst., with the President, Professor F. C. Lea, of Sheffield University, in the chair. He was supported by Sir Henry Fowler, Dr. H. S. Hele-Shaw, and a large company of members. Professor D. A. Low, Emeritus Professor of Engineering, East London College, was elected President for the ensuing year, to take office next July at the summer meeting, which is to be held in Birmingham. The Society has given £25 a year during each of the last three years in the form of twenty-five Whitworth Society prizes for the encouragement of successful competitors in the examination for National Certificates. Further information concerning the Society may be obtained from the Honorary Secretary, Whitworth Society, c/o Institution of Mechanical Engineers, Storey's-gate, London, S.W. 1.

Fuel for Merchant Ships.*

By J. JOHNSON.

As interest in this question continues unabated, the Council of the Institution felt that further discussion might serve to clarify the issues involved, and in deference to its wishes this paper has been prepared.

The subject is of much importance to all who are associated with ships or engaged in the production, distribution, and sale of oil or coal. Oil has definitely superseded coal in certain classes of tonnage, and is being used in increasing measure every year, with the consequence that coal is gradually being displaced, a position of anxiety to those who desire its retention. The advantages of liquid fuel require no demonstration, and it is certain, therefore, that when its cost to the user, calculated on a heat basis, approximates to that of coal, the latter is marked down for extinction. The growing adoption of oil for steam generation, the progress of the internal combustion engine, the recent developments in high-pressure steam propulsion, combined with the use of mechanical stokers or pulverised coal, indicate a need for close examination into the ultimate effects of their influence upon the fuel situation. There is for national reasons a general desire to see coal retain a place as a marine fuel, but it is necessary here to divest the matter of considerations other than those which determine the decisions of commercially interested parties.

Shipbuilders in this country are equipped to build motor ships or steamships and, with the aid of specialists, to provide the latter with modern oil or coal-burning appliances. They are therefore prepared within limits to build whatever may be specified, and to comply with the guarantees required by the shipowner as a protection against dislocation of service or excessive repairs, arising out of immature design. If the shipbuilder completes his undertaking with some gain, his real interest may be said to end there. It is true that he may, in competition, quote a lower fuel rate or a smaller gross power and consumption, but he is primarily interested in securing favourable contracts for the building of ships, irrespective of the mode of propulsion or type of fuel to be employed. The struggle between coal and oil concerns him in so far as a predominance of one or the other may involve some decline in British shipping and, with it, British shipbuilding. It is not intended to minimise the interdependence of the two, nor the influence of the shipbuilder and his associates in promoting technical improvements, but simply to indicate that it is not the shipbuilder's function to select the kind of fuel to be used, and that he has no direct financial interest in the subsequent consequences of the selection, which inevitably fall upon the owner.

The shipowner's choice of fuel is dictated by the necessity for securing and maintaining the maximum trading advantage, and he cannot be expected voluntarily to incur a competitive disability. If propulsion systems of substantially equal thermal efficiency and the same kind of fuel were universally employed, all parties would be without handicap or advantage; but in practice the individual owner endeavours to establish an ascendancy, and the choice of fuel is therefore important to the extent it affects the first cost of the ship and the cost of propelling her. Although strong and progressive shipping companies have the necessary means for ensuring that their ships shall be built and maintained at a high level of propulsive efficiency, supplies of fuel at suitable prices are essential, for it might be serious if an owner were forced to carry increased fuel costs which his competitors, by one expedient or another, were able to avoid.

The interest of fuel suppliers in this question is clear and unmistakable. Each aspires to enjoy as large a market as possible unhampered by excessive competition with vendors of similar or other fuels. Coal suppliers have doubtless abandoned such roseate dreams long ago, but the prospect is by no means so fanciful in the case of oil. While certain agencies are equipped to bunker vessels with either oil or coal, the interests which control the production and marketing of petroleum and coal respectively are, in the main, separate and distinct bodies. Opinions regarding the extent of the petroleum reserves have undergone considerable change, it being recognised to-day that they are much in excess of the estimates of a few years ago. They are very great indeed and well distributed, but controlled by a small number of companies. Similarly, there are enormous deposits of coal also widely distributed, but under the control of a large number of separate interests. It is necessary to touch upon the conditions governing the sale of both fuels.

The average annual world output of coal is approximately 1500 million tons, of which 250 million tons is British. The latter is sold in various grades, such as unscreened, large nuts, smalls and dust, for bunkers, domestic, and a variety of industrial purposes in both home and foreign markets, the prices realised on these several grades being expected to yield on the average sufficient to ensure a profit over the cost of production and handling. The price of bunker coal at British ports is regulated by competition amongst the various producing companies, with the possibility of its being undersold by oil, within sight. The total quantity of coal raised is governed first by demand for unscreened coal, and secondly by the demand for large or nut coal, but not to any extent by the demand for smalls. While much difficulty was formerly experienced in disposing of surplus smalls and dust, even at a low figure the quantity to-day, due to the use of coal cutting machinery, is a smaller proportion of the total coal raised, probably about 25 per cent., or, say, 60 million tons. As with one or possibly two exceptions there is no actual demand for smalls or dust as such, they are sold with and as part of more expensive grades, thus fetching the same price per ton in such cases as the larger constituents, notwithstanding the fact that their presence is generally objectionable to the consumer. It is not to be expected that suppliers would relieve the higher grades of the present virtual adulteration by smalls in order to sell the latter at a substantially lower price elsewhere, as they would lose by so doing. It would not be desirable to cheapen marine fuel by adding to the cost of coal used for essential industrial services, and therefore the only adjustment of this kind feasible is a slight increase on the cost of coal used for relatively unproductive purposes. A small rise in the cost of "dust-free" large and nuts might, however, be accepted due to the lower consumption. The only legitimate means of cheapening unscreened bunker coal appears to be by the substitution of quantities of smalls and dust, not otherwise disposable, for the larger sizes now present therein. Subject to their not being unduly dirty, smalls and dust are ideal for pulverising, and there would be no objection to their being used if the cost to the shipowner were reduced and the suppliers relieved of a surplus. The use of a larger proportion of smalls and dust would, perhaps, involve rather more cleaning than is presently done, but if definitely more economical than the present grades of unscreened coal, it would provide the most effective means of meeting competition from oil. Should circumstances encourage a development of this kind, it may be observed that with appropriate bunkering arrangements this type of fuel would, with few exceptions, be suitable for passenger as well as cargo vessels.

The present annual world output of petroleum is approximately 150 million tons. The economic problem of the industry has always been the disposal of the substantial percentage of residuals, including Diesel and fuel oils, for which there is a smaller general demand than for petrol and lubricating oils, which are more readily absorbed in an expanding market. Research in oil technics, therefore, has been and is being unremittingly devoted to the development of practical means of lifting from the petroleum an increasingly greater proportion of higher scale products. The total demand for the latter will chiefly determine, or at least regulate, the amount of crude oil raised, for it is doubtful if crude oil will be raised at any time to meet demand for fuel oil. In short, the latter is virtually a by-product of the more remunerative section of the oil industry, and, as matters stand, it is therefore in the interest of this industry that the use of oil-consuming equipment be stimulated so as to absorb, as far as practicable, the quantities which will become available consequent upon an increasing consumption of petrol. Whereas the price of coal both on the national and international basis is governed by free competition, the prices of petrol, Diesel, and fuel oil are somewhat arbitrary, and future price movements are therefore difficult, if not impossible, to predict. Just now they are low due to temporary overproduction, and therefore sharply competitive with coal. The petroleum derivatives—petrol, kerosene, naphtha, and lubricating, Diesel, and furnace oils—like the various grades of coal, are sold at prices which, in the aggregate, will yield a profit on the cost of production and refining. The ratio of these constituents can be varied greatly, and, in fact, is varied to meet changing requirements, prices being adjusted according to demand, so as to maintain, as far as possible, a suitable average selling price. Cost of distribution is important, and in the case of Diesel and boiler oils affects the price at which competing oil interest can profitably offer supplies at the various bunkering ports throughout the world. The price of oil at such ports is regulated by competition when it exists, and, when it does not, by the price of coal, actually or potentially available thereat. The relative price of Diesel and boiler oils varies according to locality. The former is about 5 per cent. higher in calorific value and conforms to a stricter specification, and more care has to be exercised in its transport and storage than with furnace oils, which can be freely mixed and handled. On occasion and at certain ports both oils may be sold at the same price, but more generally Diesel oil is 5s. to 10s. per ton dearer, and at some ports almost double the price of boiler oil. In whatever ratio the petroleum derivatives may be varied in conformity with changing engineering requirements, such as the application say, of high-speed Diesel engines to aircraft, road vehicles, and other purposes, it is reasonable to suppose that their prices would be so regulated as not to diminish the gross returns on the crude petroleum.

Fuel is the pivot upon which industrial activity turns, and national security and prosperity are the standards by which choice of fuel must be judged. While it is imperative to have ready access to fuel to maintain control of the seas and transport of food in time of war, it is essential to this country's economic welfare to have control of fuel supplies in time of peace. Apart from shipping, British industry depends upon cheap coal, and in this respect its position is quite sound. British ships are mainly engaged in carrying exports from and imports to this country, and fill an important *rôle* in enabling manufactured goods to be sold abroad against foreign competition. Their earnings in this and other carrying trades are an important contribution to national income, and when coal or oil owned by British interests is used without impairing the competitive power of manufacturer or shipowner, a position of maximum advantage is attained. When fuel is bought from foreign suppliers, the national receipts are diminished, but if its use enables propulsion costs to be reduced, to the benefit of the country's general trading position, then the situation may have to be accepted. Monopoly or curtailment of supplies may be a remote contingency, or not even a possible one, but in any case users cannot be expected to shoulder a present trading disability against a hypothetical future danger. The general adoption, however, of a system of propulsion which would make the mercantile marine entirely dependent upon a continuance of supplies of a special grade of oil at a suitable price, raises issues of immense importance, and it behoves all concerned to consider carefully the implications. It is axiomatic that cheap fuel is essential for economical transport, upon which free flow of traffic depends, and it is clearly to the advantage of trading communities, shipowners in general and British shipowners in particular, that coal should not be driven out of the marine market, but, on the contrary, that it should retain its place as an effective competitor of oil. So long as ships are able to use coal, the inducement to sell oil at attractive prices will necessarily remain. Remove this dependable check and the matter then lies between competing oil interests, a condition not without danger to consumers. Whatever safeguards there may be in the form of competition among oil suppliers, they are manifestly strengthened by the competitive power of coal. It is impossible to over-estimate the strategic advantage and bargaining power underlying the ability to use either coal or oil at option. This desirable position, however, can only be realised if the type of propelling machinery reaches the requisite standard of efficiency, and is in every respect quite suitable for the duty contemplated.

Consider the scope of the problem. There are approximately ten thousand vessels, aggregating twenty-three million gross tons, owned by Great Britain and the Dominions. One-fifth of the number is propelled by oil, and of these there are roughly nine hundred motor ships and eleven hundred steamships, representing together nine million tons, or 40 per cent. of the total tonnage, which figures convey the extent to which British merchant ships now depend upon oil. The decline in the use of British coal for bunker purposes is indicated in Tables I. and II.

In order that the relationship between fuel and tonnage may be better understood the total number of vessels has been roughly divided into three classes—Table II.—the first comprising express passenger ships, in which, owing to considerations of cleanliness and very short inport

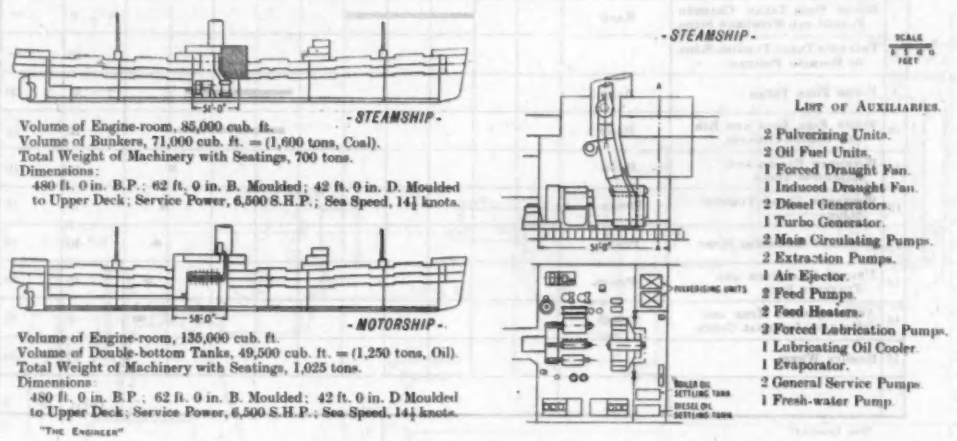

-STEAMSHIP-
Volume of Engine-room, 85,000 cub. ft.
Volume of Bunkers, 71,000 cub. ft. = (1,600 tons, Coal).
Total Weight of Machinery with Seatings, 700 tons.
Dimensions:
480 ft. 0 in. B.P.; 62 ft. 0 in. B. Moulded; 42 ft. 0 in. D. Moulded to Upper Deck; Service Power, 6,500 S.H.P.; Sea Speed, 14½ knots.
-MOTORSHIP-
Volume of Engine-room, 135,000 cub. ft.
Volume of Double-bottom Tanks, 49,500 cub. ft. = (1,250 tons, Oil).
Total Weight of Machinery with Seatings, 1,025 tons.
Dimensions:
480 ft. 0 in. B.P.; 62 ft. 0 in. B. Moulded; 42 ft. 0 in. D Moulded to Upper Deck; Service Power, 6,500 S.H.P.; Sea Speed, 14½ knots.
"THE ENGINEER"
-STEAMSHIP-
SCALE
0 5 0 0 FEET
LIST OF AUXILIARIES.
2 Pulverizing Units.
2 Oil Fuel Units.
1 Forced Draught Fan.
1 Induced Draught Fan.
2 Diesel Generators.
1 Turbo Generator.
2 Main Circulating Pumps.
2 Extraction Pumps.
1 Air Ejector.
2 Feed Pumps.
2 Feed Heaters.
2 Forced Lubrication Pumps.
1 Lubricating Oil Cooler.
1 Evaporator.
2 General Service Pumps.
1 Fresh-water Pump.
-MOTORSHIP-
SCALE
0 5 0 0 FEET
LIST OF AUXILIARIES.
3 Diesel Auxiliary Generators.
2 Manœuvring Compressors.
2 Manœuvring Air Reservoirs.
4 Scavenging Blowers.
2 Lubricating Oil Pumps.
1 Lubricating Oil Filter.
1 Lubricating Oil Separator.
1 Fuel Oil Transfer Pump.
2 Cooling Water Pumps.
1 Ballast Pump.
1 Bilge and Sanitary Pump.
1 Donkey Boiler.
1 Donkey Boiler Feed Pump.
1 Lubricating Oil Cooler.
1 Fresh-water Pump.
Swan Sc.

FIG. 1—COMPARISON BETWEEN A TURBINE-DRIVEN STEAMSHIP AND A MOTOR SHIP

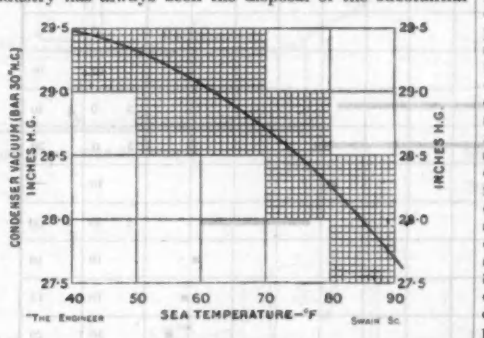


FIG. 2—SEA TEMPERATURE AND CONDENSER VACUUM

* Read at the Institution of Naval Architects, March 17th, 1932.

stays, the use of coal is generally inadmissible; the second embracing the speedier cargo and intermediate vessels, and the third the large batch of vessels below 12 knots, in both of which these considerations are less important and the choice of fuel is controlled by cost. A considerable percentage of the tonnage included in Classes B and C is old and propelled by old-fashioned inefficient machinery. It is to-day more of a liability than an asset, and even in the event of a trade revival it is questionable whether it would become a satisfactory working asset. General trade considerations may ultimately cause a permanent shrinkage in the gross amount of British tonnage; also, the adoption of somewhat higher speeds, arising out of the use of more economical propelling agents, will tend to a contraction of the number of units required for certain trades. It is therefore probable that numbers in Class B will increase at the expense of the slower tonnage in Class C. The division between these two classes is, of course, an artificial one, and is adopted in order to treat the technical and commercial issues involved in their replacement, which will gradually become necessary.

TABLE I.—*British Bunker Coal.*

	1913.	1922.	1925.	1930.
	Tons.	Tons.	Tons.	Tons.
Taken at United Kingdom ports ..	21·0	18·2	16·4	15·6
Taken at foreign bunkering stations	9·2	6·5	5·2	4·9
Total tons (in millions)	30·2	24·7	21·6	20·5

TABLE II.

Class.	Number.	Tonnage.	Percentage.
A. Vessels having upwards of 10,000 H.P.	130	2,500,000	11·0
B. Vessels having between 3000 and 10,000 H.P.	1000	7,250,000	31·5
C. Vessels having less than 3000 H.P.	8800	13,250,000	57·5
	9930	23,000,000	—

In order to illustrate suitably the case of vessels in Class B, a design of a typical good class cargo boat of 14–15 knots sea speed—6500–7000 H.P.—has been selected—see Fig. 1—and a comparison framed between the high-pressure geared turbine and the most modern and commercially attractive type of Diesel engine, each driving a single screw. It may be observed that for vessels of this class, unless of limited draught, single-screw propulsion ought to be quite suitable. In passing, it is interesting to note that the largest single-screw vessels built were the s.s. "Unbria" and s.s. "Etruria," of approximately 13,000 S.H.P.

Starting with the relative costs of steamship and motor ship, both having electric winches and several items of auxiliary machinery in common, one would expect that the cost of the steam installation, by reason of its less weight, would be considerably cheaper. If both were of British manufacture, this would unquestionably be the case, the difference being of the order of £20,000. British shipowners, however, may purchase Diesel engines from Continental suppliers for the same reason and, doubtless, with the same justification as foreign owners come, or used to come, to this country for ships. In these circumstances the cost of the motor ship may only be slightly dearer than the steamship of the same net cargo deadweight. In order to simplify comparison it would therefore be safer to assume equality of first cost. Repair costs are always somewhat controversial, but although the author is of opinion that modern steam machinery takes pride of place in low running expenses, there is no objection at the moment to accepting the view that there is nothing to choose between the two systems. As the same number of engineers and ratings will suffice for both ships, the issue is narrowed down to the cost of fuel and lubricating oil, and any differences that may exist in cargo-carrying facilities.

The two-stroke double-acting Diesel installation of this power would weigh 1025 tons, including seatings; fuel consumption for all purposes, 0·39 lb. per S.H.P.-hour; consumption of lubricating oil, 24 gallons per day. The engine works between initial and exhaust pressures of 750 lb. and atmosphere respectively, the corresponding temperatures being about 2500 deg. Fah. and 600 deg. Fah. The piston speed would be about 1000ft. per minute, and propeller revolutions 100 per minute. The fuel consumption quoted has already been recorded on service.

The steam installation would weigh 700 tons, including seatings; fuel consumption for all purposes per S.H.P.-hour, 0·53 lb. of oil, or 0·76 lb. of coal, including 4 per cent. pulverising duty; consumption of lubricating oil, 6 gallons per day. Range of working pressure, 500 lb. to 0·75 lb. absolute; range of temperature, 800 deg. Fah. to 90 deg. Fah.; average vacuum, 28·5in.; revolutions of propeller, 100 per minute. These fuel rates, oil and coal, vouched for by responsible parties, are based upon a boiler efficiency of 90 per cent.; 0·74 lb. of steam per S.H.P.—turbines only—and feed heating in two stages to 325 deg. Fah. With the exception of the feed pumps, the remaining small number of auxiliaries would be electrically driven, current being supplied by a Diesel or turbo-generator. Diesel generators would be used for port purposes, and the ships would be alike in this respect. Simple provision would be made in the design of the boiler for reducing the steam temperature from 800 deg. Fah. to 600 deg. Fah. for manœuvring. Make-up feed would be about 7 tons per day, and 100 tons of fresh water would be carried for this purpose. As the quantity of steam required for auxiliary purposes is insignificant, and there is no contaminated exhaust steam, the installing of an auxiliary boiler is not warranted, and in these circumstances the raw fresh water would be passed through a large-capacity evaporator, worked at a low rating. It may be recalled that the fuel rate of the s.s. "Duchess of Bedford" is 0·57 lb. for propulsion, with two engines each of 9000 S.H.P., 350 lb. working pressure, 675 deg. Fah. steam temperature, 29in. vacuum, and 85 per cent. boiler efficiency. In cargo ships the difference between the propulsion and all-purposes figure is negligible, unless there is a large refrigerating load, and it will be seen, therefore, that after allowing for improvements in boiler efficiency and thermal conditions, the figure of 0·53 lb. quoted above is well founded. With modern condensing plant, consistently better vacuum is now being obtained, and even with sea temperatures of 85 deg. Fah. fully 28in. is realised, while in cold climates 29·25in. is being steadily registered, so that an average of 28·5in. for a mixed voyage can be counted upon. Reference to the curve, Fig. 2, giving the relation between sea water temperature and vacuum, should be made; it is based on modern practice.

Fuel expenses of vessels trading between the United Kingdom and remote ports depend largely upon the relative prices of coal, boiler and Diesel oils, and these must be applied judicially if their influence is to be accurately assessed. Fifteen shillings per ton is a fair average price for coal of good quality taken at home ports. The lowest rate for Diesel oil of which the author has evidence is 30s. per ton, the corresponding price for boiler oil at the same port being 24s. per ton, while the lowest rate quoted anywhere for furnace oil is approximately 16s. per ton. While present-day prices for boiler and Diesel oil at certain ports reach levels as high as 60s. and 65s. respectively, comparisons must be made on the basis that parties are comparatively free to choose their bunkering ports, and that the steamship and motor ship would, in a general way, both bunker to the best advantage.

TABLE III.

	Fuel per S.H.P./hour all purposes, lb.	Fuel per day, tons.	Fuel cost per day (at sea).
			£ s. d.
Motor ship—6500 S.H.P. Diesel oil at 30s. per ton ..	0·39	27·2	40 16 0
Excess lubricating oil ..			3 4 0
			44 0 0
Steamship—6500 S.H.P. Boiler oil at 24s. per ton ..	0·53	36·9	44 5 0
Steamship—6500 S.H.P. Coal at 15s. per ton ..	0·76	52·9	39 15 0
Steamship—6500 S.H.P. Coal for half voyage (15s. per ton) .. / Boiler oil, half voyage (24s. per ton) ..	—	—	42 0 0

Table III. is based on the lowest comparable fuel prices prevailing, but if, for example, Diesel and boiler oil prices are moved up the scale to 45s. and 40s. per ton respectively, coal standing at 15s., the average daily fuel costs incline in favour of steam to the further extent of £5 per day, and it should be noted that this difference grows as the higher limit of the oil price scale is approached. So far as fuel costs are concerned, therefore, the position of steam propulsion is a strong one, apart from the advantage inherent in the optional use of fuel. The British shipowner may to-day, by purchasing Diesel engines on the Continent, obtain a motor ship at a cost equal to that of a steamship built entirely in this country. If, however, the general conclusions now outlined be accepted as substantially true, the owner may obtain a vessel of much greater commercial utility without having recourse to the purchase of foreign engines. The price of that fraction of petroleum which is more suitable for burning in furnaces than in internal combustion engines is likely to be cheapened if in direct competition with coal, and it should be observed that when both oils are at a low price level the steamship compares very favourably with the motor ship in fuel costs. The significance of this is that in building steamships of this kind the owner is exposed to no commercial hazard, inasmuch as they can be operated profitably on oil. The point is mentioned in anticipation of objections that powdered coal is somewhat experimental in this specific application.

Much has been said, and justifiably so, of the great radius of action of the motor ship. Be it observed, however, that she takes fuel at a cheap oil port for the journey to the United Kingdom and back again, whereas the steamship only requires to take coal for half that distance, wherever the cheap oil port may be located. Subsequent thereto, if both vessels are working between cheap oil ports, the steamer, due to lighter machinery, starts with an initial advantage of 225 tons, and as her daily fuel consumption is roughly 10 tons greater, she may bunker for twenty-two days' steaming, or approximately 8000 miles, without loss of deadweight, as compared wth the motor vessel. She may, of course, vary this arrangement if cheap coal is available at intermediate ports, and it is evident, therefore, that not only is her radius of action good enough for all practical requirements, but it is less strictly conditioned. A vessel designed to carry a certain weight of cargo of average density will have space to spare when loaded to her marks with a heavy cargo, and draught to spare when her space is filled with a lighter cargo. In the former case fuel is always a deduction from the weight of cargo which the ship can lift, irrespective of whether it is carried in double-bottom tanks or at a higher level. With measurement cargo, all available space can be utilised if liquid fuel is carried in the double-bottom tanks. In the modern steamer and motor ship of identical dimensions—see Fig. 1—the machinery of the former occupies 50,000 cubic feet less space than the Diesel installation, and as, in a general way, outward cargoes are heavy and homeward cargoes lighter, it follows that while she carries less cargo during the outward voyage due to weight of coal, she carries a greater volume of cargo on the homeward voyage when maximum space is the desideratum. This is illustrated in Table IV, from which it will be seen that when there is full employment both ways the combined revenue for outward and homeward voyages would not differ appreciably in the two cases. In an appendix, which we do not reproduce, further particulars regarding size of machinery spaces and net tonnage and exchange rates are given.

(To be continued.)

TABLE IV.

Machinery (including seatings).	Fresh water.	Fuel for 30 days.	Total weight: machinery, water, bunkers.	Cargo deadweight.	Cargo space.	Remarks.
Motor ship—6500 S.H.P. 1025 tons	Nil	816 tons (oil)	1841 tons	Datum	—	Condition of vessels leaving U.K. port on outward voyage
Steamship—6500 S.H.P. 700 tons	100 tons	1585 tons (coal)	2385 tons	Minus 544 tons	—	
Motor ship—6500 S.H.P. 1025 tons	Nil	1632 tons (Oil for 60 days)	2657 tons	—	Datum	Condition of vessels leaving outward terminal port for homeward voyage
Steamship—6500 S.H.P. 700 tons	100 tons	1110 tons (Oil for 30 days)	1910 tons	—	Plus 50,000 cubic feet	

SIXTY YEARS AGO.

BY the term "torpedo" there was at one time meant either what we would now call a mine or an explosive charge towed by a vessel at the end of a rope or pushed in front of her at the head of a pole projecting from her bow. Then came Whitehead, with his self-propelled submarine torpedo. That device was at first received by many people with something little short of derision, but very quickly its influence began to be felt in naval circles. Anxious thought was devoted to the best means of protecting war vessels against the new weapon of attack. Thus Mr. C. W. Merrifield, in a paper read before the Institution of Naval Architects, and reprinted in our issue of March 29th, 1872, discussed the effects of torpedoes on naval construction. He spoke of cellular subdivision, but was not enthusiastic about it, because of the inconvenience which it would cause to those operating the ship. He touched upon the possibility of armouring the bottom as well as the sides of the ship, but dismissed the suggestion on the ground of excessive weight. He mentioned the possible use of nets suspended 6ft. or 8ft. from the ship's sides, but while approving of their use in certain circumstances, he considered that they would prove "terrible impediments" to speed and manœuvrability. There remained but one other suggestion—bulges. Mr. Merrifield did not use that term, a term which was not to become familiar until the Great War had run half its course, nor did his proposal follow exactly the lines which were to be adopted some forty odd years later. But the principle of the bulge was clearly incorporated in his ideas. He proposed that a warship should have three skins, spaced about 18in. or 2ft. apart, and that the spaces between the skins should be divided into cells. The space between the outer and middle skin was to be preserved full of water by fitting each cell with a non-watertight manhole in the outer skin. The air between the middle and the inner skins was to serve as a cushion. An important feature of the proposal was that this air cushion should be given an opportunity to act effectively by deliberately weakening the middle skin at one point in each cell in order that the explosion, having penetrated the outer skin, should drive the water between it and the middle skin through the disrupted weakened patch against the air cushion between the middle and inner skins. Mr. Merrifield believed that his paper contained the first suggestion which had yet been made public for providing structural means of enabling a ship to resist torpedo attack. He thought that his suggestion would be welcomed by his audience "partly for its own sake, but far rather as the harbinger of more."

IT is reported by the National Federation of Iron and Steel Manufacturers that there were seventy-one furnaces in blast at the end of February, a net decrease of five since the beginning of the month, six furnaces having ceased operations and one furnace having been blown in. The production of pig iron in February amounted to 318,100 tons, compared with 330,000 tons in January, and 318,200 tons in February, 1931. Production included 75,400 tons of hematite, 120,000 tons of basic, 105,600 tons of foundry, and 10,600 tons of forge pig iron. The output of steel ingots and castings amounted to 480,600 tons, compared with 429,700 tons in January, and 486,400 tons in February, 1931.

WHAT is known as centralised traffic control is a recently introduced method whereby a control officer can take charge of all the running and shunting movements in an area. All the lines are track circuited, and their condition of occupied or free is repeated on an illuminated diagram in front of the officer. The sidings, cross-over roads, junctions, and other connections are operated by power from the control office and the signals also. The controller knows all the movements each train has to make, and, by means of the illuminated diagram, watches its approach to a station and moves the points and signals to suit. The first installation of centralised traffic control in this country will be that on the Metropolitan Railway Company's new branch to Stanmore, when it is opened later on in the year. The control will be in Wembley Park signal-box, and the man there will operate the whole branch, 4½ miles long, including the Stanmore terminus and three intermediate stations.

The Machinability of Steel as Indicated by its Macrostructure.*

By F. E. ROBINSON, M.I. Mech. E., and C. T. NESBITT.

Introduction.—The art of drilling long holes of small diameter has been known for generations to those connected with the gun trade. Between twenty and thirty years ago, the practice was to produce the hole in a rifle-barrel forging by drilling from both ends. The hole was drilled a few inches at a time, the drills finally meeting at or about the centre of the barrel. The holes produced by this method, although regular as regards diameter, were by no means straight. The art of straightening the bore required patient training and considerable skill, the method employed being to cast a shadow by reflected light inside the bore. The Pratt and Whitney Company, of Hartford, U.S.A., some years before the war, designed a machine for drilling rifle barrels from one end. After a long series of experiments this method was adopted at the Royal Small Arms Factory, Enfield, and the old types of drilling machine were converted into machines which resembled, in principle, the Pratt and Whitney machine. After some years of experiment the type of drill used was standardised, and is known as a "D" bit. The Pratt and Whitney machine is shown in Fig. 1, the Enfield machine in Fig. 2, and the bit in Fig. 3.

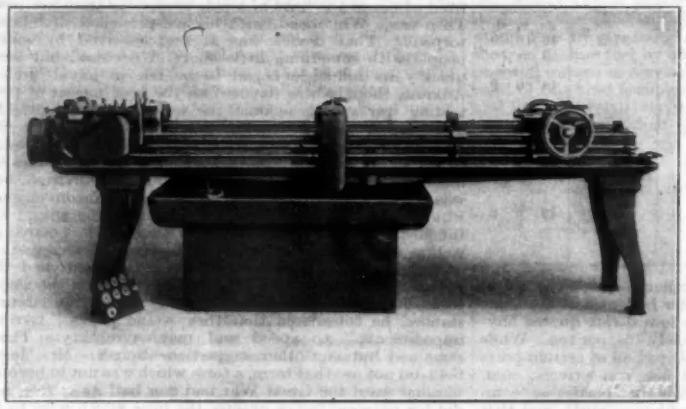


FIG. 1—RIFLE DRILLING MACHINE—PRATT AND WHITNEY

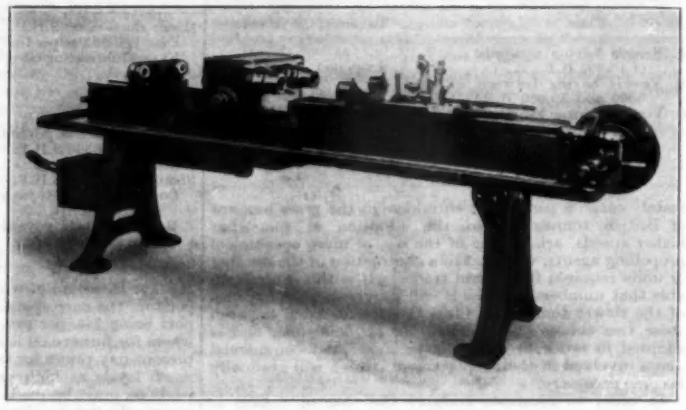


FIG. 2—RIFLE DRILLING MACHINE—ENFIELD

An essential feature in drilling long holes is the use of a cutting lubricant under high pressure. Mineralised lard oil at a pressure of 800 lb. to 1000 lb. per square inch is forced through the hollow tube which holds the bit at one end, and serves the double purpose of cooling the tool and forcing the chips or swarf from the bore.

With the introduction of the type of machine referred to, considerable difficulty was experienced in obtaining from makers of rifle-barrel steel a material which could be drilled uniformly, both as regards the finish obtained in the bore, and the concentricity of the bore in relation to the outside diameter of the barrel itself. So serious was this difficulty that it was found necessary, when drilling rifle barrels from one end, to drill the hole from the rough forging and then turn the external diameter from the bore. After a series of trials of steel supplied by several makers, one or two firms were eventually found who were able to supply steel which could be drilled with generally satisfactory results. The bore was bright and smooth and reasonably straight, but, unfortunately, none of these firms appeared to be able to supply steel which was uniformly satisfactory; some consignments were good and others decidedly indifferent. Owing to the war further investigations into the problem could not be actively pursued, and the years immediately following the war found the Royal Small Arms Factory with large consignments of steel which were giving anything but satisfactory results in the drilling operation.

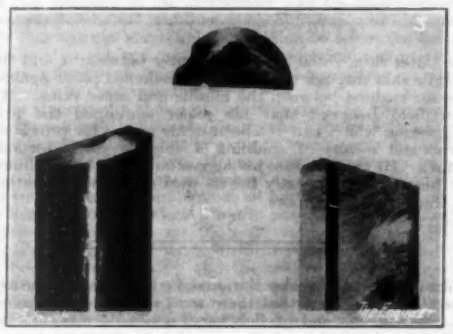


FIG. 3—"D" BIT

Some six or seven years ago, a well-known firm of steel-makers in Sheffield asked the factory authorities to try a few of their barrel forgings made to the War Department Specification for Barrel Steel (see Specification No. 1, Appendix II.), and the results were markedly superior to any hitherto obtained. Small orders were then placed with the firm in question for standard bars of steel from which forgings were made at the Royal Small Arms Factory. The results obtained were not up to the standard of forgings supplied by the firm. The problem of the variability in the drilling properties of rifle-barrel steels was discussed with a member of this firm, and he suggested that a solution of the problem might be obtained by examination of the macrostructure of the steel. It was suggested that, provided the correct macrostructure was obtained in the rolled bar, any subsequent manipulation of the bar would not in any way alter the drilling properties of the steel.

A further contract for the supply of barrel steel was placed with the firm, in which the standard specification was modified and a clause inserted to govern the drilling properties of the steel. This clause embodied a drilling test of the bar material as supplied by the makers; this test was to be carried out by the factory in a standard barrel-drilling machine and the hole produced was required to be straight and of high finish. The drill was required to penetrate the bar, some 26in. long, without needing to be resharpened. The reason that tests were specified on the bar instead of forgings made from the bar was to avoid any unfairness to the contractor due to possibly faulty treatment of the steel during the forging process at the Royal Small Arms Factory, although this was considered to be an unlikely occurrence. The steel supplied under the contract was very satisfactory, both in the specification test and in the results obtained when drilling the forged barrels during the ordinary course of production.

Simultaneously trials were continued, using the same machines and the same operator, on the old stock of steel, and the drilled holes were consistently inferior to the steel to the new specification. While shop trials were going on, specimens cut both from bars and forgings were prepared. These pieces consisted of transverse sections for microscopic examination of the steel and longitudinal sections through the axis of the bar for macroscopic examination. No appreciable difference beyond variation in grain size was discovered by microscopic examination, the steels revealing the characteristic structure of a good commercial steel of 0·5 to 0·6 per cent. carbon content in the normalised condition. Various etching reagents were tried on the longitudinal sections, and it was found, after many experiments, that the reagent known as Rosenhain and Haughton's gave the best results. This reagent revealed the structure which metallurgists term somewhat loosely "forging lines," or "phosphide lines," and it was found that these lines varied considerably in the different batches of steels on which the drilling tests were conducted.

In the steel which gave the best results on the barrel-drilling machines, etching with Rosenhain's reagent revealed very definite and well-defined lines or bands which were practically parallel in the direction of axis of the bar. In all the steels which gave unsatisfactory results in drilling, the etched surfaces revealed the characteristic lines but these were in all cases forked and irregular or much finer in structure.

Following these investigations, inquiries were issued to several well-known firms who had in the past been regular contractors for rifle-barrel steel and the firms were invited to send a member of their technical staffs to see the result of the works and laboratory tests which had been carried out. There was a certain amount of scepticism regarding the reliability of macro-examination as a guide to the suitability of a steel from the point of view of drilling a rifle barrel, but when trial orders were placed, one firm, and one firm only, reproduced the structure required, and the steel proved entirely satisfactory. None of the other firms reproduced the structure required and the steels proved most unsatisfactory in practical workshop tests. For a period of many months, trials were continued and a summary of the results is submitted in this paper.

At a later date these methods of investigation were applied to other machining problems on bar materials with a view to ascertaining whether macrostructure could be used as an index of the machining properties of steel. These further investigations have now been carried on over a period of two years, and the results obtained have convinced the authors that macrostructure is a definite index of the machinability of steel.

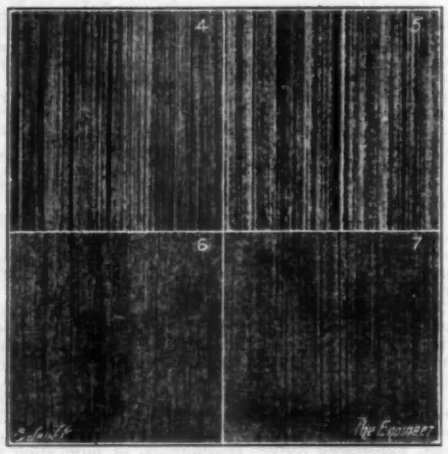
Preparation of Specimens.—In the first series of investigations of macrostructure, short sections, from 1in. to 1½in. long, were cut along the axis of the bar, polished and etched; these were, in fact, the same pieces as those used for micro-examination of the transverse sections. It was soon found preferable to use longer sections in order to study more effectively the macrostructure revealed by the reagent finally selected. The length adopted was 4in., and although the final polishing of a piece of steel of this length is somewhat slow, there is no doubt that the longer specimens give far more information than short pieces.

In preparing the test pieces the bar is milled down approximately to its axis. It is then ground on a surface grinding machine and finally rubbed down in the ordinary way on emery cloth and paper of increasing fineness. Care is taken that the grinding and final rubbing down is done at right angles to the axis of the bar. Final polishing is done on a revolving chamois-covered wheel loaded with chalk. It has been found by experience that in preparing specimens for macroscopic examination almost as much care is necessary as in the preparation of specimens for microscopic investigation.

For the etching reagent, as has been mentioned, various reagents were tried, including Stead's and Rosenhain's. Stead's reagent was tried, as it was known that he had developed, by etching longitudinal sections of steel, a banded structure, termed by him "phosphide lines." Rosenhain's reagent (Appendix I.) was adopted as the standard reagent as it appeared to give the most satisfactory results.

A sufficient quantity of this etching reagent is poured into an ordinary quarter-plate photographic developing dish to cover the test piece. The test piece is thoroughly cleansed with alcohol and immersed below the reagent in the dish. In the course of a few minutes lines or bands, appearing alternately light and dark, begin to show and can easily be seen with the naked eye. In the case of a good machining steel these lines or bands appear in about five minutes' time, but the reaction is frequently delayed, and the surface of the steel, instead of showing finally a fine film of copper, becomes muddy and dark. In certain cases polishing has to be resorted to and the characteristic macrostructure only appears fully after repeated etchings. Experience has shown that a steel which is etched with difficulty, and which shows a muddy surface in the etching bath, gives definitely bad results when it is machined. Combined with this slow response to the etching medium, the macrostructure developed is always faulty. The bands or lines are forked, or are too fine, and, if carefully examined, will also be found to be forked in the latter case. In certain instances small spots appear, as if the reagent were attacking some impurity in the steel.

Examination of Rifle-barrel Steels.—The preliminary trials on barrel steel to determine if possible the causes of the variation in the drilling properties of the material, have been briefly referred to in the introduction. It is necessary to give in some detail the various tests that were undertaken prior to the investigation now recorded. The object was to eliminate possible variables and to determine whether certain accepted theories regarding the machining properties of free-cutting steels applied to steels of 0·5 to 0·6 per cent. carbon content. The tests were for:



FIGS. 4 TO 7

(1) Form of drill bit and cutting angles of bit.

(2) The most suitable steel for the drill. A semi-high-speed steel containing about 4 per cent. tungsten was found to be the best. True high-speed steels are not so good for this special purpose, though very recent experiments have shown that possibly the latest super-high-speed type of steel may replace this semi-high-speed steel with improved results.

(3) The best speed and feed. A cutting speed of 90ft. per minute and a feed of 0·375in. to 0·5in. per minute, was found best.

(4) Oil pressure. To obtain best results on the finish of the drilled hole the oil pressure fed to the point of the bit requires to be from 800 lb. to 1000 lb. per square inch.

(5) Heat treatment. Normalising, namely, heating

* The Institution of Mechanical Engineers.—March 18th

to 800 deg. Cent. and cooling slowly in air, gave good results, and conformed to the mechanical tests required by specification. Other heat treatments, such as toughening—oil-quenching and tempering—were tried without improving these results.

(6) Relationship between the manganese and sulphur content of the steel, together with the phosphorus content. This is usually assumed to be a feature of free-cutting steels. Variation in these elements was found to have no influence on the drilling properties of rifle-barrel steel.

(7) Presence of impurities. No evidence of abnormal impurities was discovered in the various steels examined. Further data on this point is given later in the paper.

(8) Microstructure. Little variation in microstructure was found among the steels examined. Considerable variation in grain size of the characteristic ferrite and pearlite structure made no difference.

(9) Brinell hardness. With barrels in the normalised condition, a fairly wide variation in Brinell hardness had no effect on the results obtained in drilling tests.

All these points had been dealt with without obtaining any uniformity in the quality of finish of the drilled hole, when it was suggested that macroscopic examination might be tried. Macroscopic examination of several steels was carried out in the manner described above, and considerable variation discovered. At the same time, drilling tests of the bars before forging were performed. Figs. 4, 5, 6 and 7 show the variation in macrostructure of the steels tried. The bars with the macrostructure shown in Figs. 4 and 5 could be drilled without the slightest difficulty, the finish of the hole being bright and straight with no rings or scores in the bore. The holes in bars exhibiting the macrostructure shown in Figs. 6 and 7 were dull in appearance; they did not run straight and the bores were scored or torn in places where the drill had been slightly deflected from its normal path, or where the material had "picked up" on the edge of the tool. In most cases the tool had to be removed from the bore and resharpened at least once.

Tests carried out on forged rifle barrels made from the remaining portions of the test bars gave identical results, despite the fact that macrographs of the barrels showed the characteristic deformation of the bands due to hot working under both steam and Ryder forging hammers. The regular macrostructure, characteristic of the bad drilling steels, could be traced in the forgings; the structure of the good steels was much more regular and the bands or lines more continuous. It has been definitely established that once the correct macrostructure has been obtained in bar or billet, subsequent forging does not alter the drilling or machining properites of the steel.

APPENDIX I.

COMPOSITION OF ROSENHAIN AND HAUGHTON'S ETCHING REAGENT.*

Ferric chloride (Fe_2Cl_6)	30 grammes
Hydrochloric acid (conc.)	100 c.cm.
Cupric chloride ($CuCl_2$)	1·0 gramme
Stannic chloride ($SnCl_2$)	0·5 "
Water	1 litre

APPENDIX II.

No. 1. Excerpt from Specification S.W.E. No. S/30 governing the Supply of Steel for Rifle Barrels.

To be of the best quality steel free from seams, flaws, hard points, pins or other defects.

The ends of the bars to be sawn at right angles to the length and must be free from burrs.

The bars will be either rolled or forged at Enfield, and must act satisfactorily in drilling, boring, and turning.

An analysis of the steel should show a composition as follows:—

	Per cent.
Carbon	From 0·5–0·6
Silicon	Not above 0·25
Manganese	From 0·5–0·7
Phosphorus	Not above 0·03
Sulphur	" " 0·03

Standard tensile test pieces will be cut from the barrel bars after rolling or forging at Enfield and shall show:

Yield-point	Not less than 26 tons per sq. in.
Ultimate stress	" " 45 " "
Extension	" " 15 per cent.
Contraction of area	" " 35 per cent.

(To be continued.)

Canadian Engineering News.

Vancouver's Tunnelling Project.

AN important stage in the construction of Vancouver's new pressure tunnel, which will carry the city's water supply under Burrard Inlet, at First Narrows, was reached with the sinking of the shaft in Stanely Park to a depth of 400ft. and the starting of the heading. Shaft sinking is also proceeding on the North Shore, and at 100ft. had approached within 5ft. of bedrock. On the completion of this shaft to its required depth of 400ft. drifting will also commence from that end. Between the two shafts a tunnel 3100ft. long and 7ft. 6in. in diameter will be constructed, and 4700ft. of 70in. pipe will be laid through Stanley Park to connect with the city's mains. The whole project will cost approximately 1,200,000 dollars, and its completion will allow the city to draw an additional 25 or 30 million gallons a day from Capilano Creek, the present source of Vancouver's water supply.

New Oil Refinery.

A new oil refinery with a capacity of 1000 barrels daily has been completed at Manchester, a suburb of Calgary, Alberta, and will be operated by the Bell Refining Company, Ltd., a new organisation controlled in Alberta. The plant will use 75 per cent. Turner Valley naphtha, blended with 25 per cent. of southern petroleum in the manufacture of its products.

Large Typewriter Industry.

The complete manufacture of Underwood typewriters in Canada will be undertaken very shortly by the United Typewriter Company, Ltd., which hitherto has been the Canadian distributing and assembling representative of the Underwood Typewriter Company of the United States. It is indicated that the building of machines for export to Great Britain will be an important factor in the company's expansion plans.

Reconstruction Completed at Saint John.

The opening of the 1931–32 shipping season for the port of Saint John took place on December 1st, and the occasion also marked the completion of the reconstruction work on the west side. At West Saint John the disastrous fire of last June reduced the water front to ruins and since that time a major reconstruction programme has been rushed through under the direction of the Harbour Commissioners. During some twenty weeks of reconstruction the harbour at West Saint John was provided with six berths complete with steel sheds and grain conveyors and also a frost-proof warehouse of 30,000 barrels capacity. The restored facilities will enable the business of the port to be carried on efficiently during the winter.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Position Unchanged.

LITTLE variation is perceivable in the industrial position of the Midlands and Staffordshire, but the prevailing tendency continues as last week towards a gradual improvement. The strengthening of the National position and the easing of the bank rate both afford grounds for encouragement, but the month has advanced far now, and with the Easter trade disturbance intervening, there is little prospect of any marked revival until next quarter. It is noticeable, however, that at recent annual meetings of local manufacturers, the views expressed by the chairmen and managing directors as to future prospects are all in optimistic vein. It is in marked contrast to many of their utterances twelve months ago. Naturally, thoughts are now turning towards the Budget, and representations are being made to the Government for relief of taxation. It is much hoped that the response will be such as to encourage manufacturers and others to proceed with projects at present held in abeyance. Unfortunately for constructional engineers, pressure is being brought to bear upon local authorities for relief of local calls, and from the decisions arrived at by many Corporations and Councils it would appear that rates are to be kept down by the continued exercise of strict economy. There is not likely to be much money allocated to development schemes such as would afford substantial business for the constructional engineering firms. Work at present laid aside will probably be shelved for a further six or twelve months. It is to be hoped that trade will show such an improvement in the near future as to justify manufacturers entering upon works extensions and so to provide some employment for local engineering firms. In other branches of heavy engineering the prospects, while in no way bright, are hardly on such unproductive ground as in the structural branch. Light engineering works are faring better than they were, and the outlook is gradually brightening. The past week has brought no noticeable increase in demand for iron and steel, and market activity in Birmingham has been of a restricted character. Stocks at some of the works in the finishing trades are sufficient with the present limited output to last for some time, while contracts in other cases cover more than enough material to see the current quarter out. Under these circumstances inquiries regarding second quarter business have not been numerous.

Steel.

There is no change to record in the finished steel market. Demand is as sluggish as it has been for weeks past, and producers are far from happy as to future prospects. Works are poorly engaged and rolling programmes are difficult to arrange. There is no change in selling prices, but it is interesting to set them side by side with those of foreign rivals, who, at date, are keenly, but unsuccessfully, pressing for business in this market. While native steelmasters want £7 12s. 6d. actual for sections, foreign firms offer supplies at £4 15s., native joists are £7 12s. 6d., foreign £4 11s. 6d.; native plates £8 2s. 6d., foreign £5 15s. In the half-products department also competition is keen, and British and foreign prices show considerable disparity. Native billets are quoted £5 7s. 6d. for English, and £5 5s. to £5 6s. for Welsh, while Belgian and French are offered at £4 5s. to £4 6s. British sheet bars are named £5 2s. 6d. to £5 5s., and foreign are £4 6s. Re-rollers want £6 10s. to £6 12s. 6d. for small steel bars, though they are now prepared in some instances to accept £6 7s. 6d.; but foreign supplies are to be had at £4 15s. to £5. Staffordshire steel works are selling small tonnages, but there is practically no business passing in foreign material. This is chiefly owing to the fact that users have ample stocks for present requirements, and those of the immediate future. Native boiler plates are in poor request, and values have fallen half a crown, the present quotation being £8 10s. Staffordshire hoops are held for £9 10s.

Raw Iron.

Conditions remain unsatisfactory in the pig iron industry in this area. Blast-furnacemen are seeking specifications against the contracts on their books, but they only come in slowly. The poor output at the foundries gives smelters but little encouragement to hope for a betterment of their position. Present production is not being absorbed and stocks are visibly increasing. Especially is this the case in Northamptonshire, where makers are not so favourably placed for the disposal of their output as those in Derbyshire allied to pipe foundries. There is no desire on the part of consumers to enter into forward commitments, and in many cases there is so much material still to be taken on old contracts that the making of new arrangements for the second quarter is at present unnecessary. Prices of iron remain steady at £3 2s. 6d. for Northamptonshire, and £3 6d. for Derbyshire. These quotations will be reviewed at the monthly meeting of the Central Pig Iron Producers' Association at the end of the month. The price of fuel is higher than at the end of last quarter, but, at any rate, in the view of foundrymen, it has not appreciated sufficiently to justify blast-furnacemen making any increase in the selling price of pig iron.

Manufactured Iron.

Staffordshire ironmasters report that the week has brought no improvement in demand, which remains on a poor scale for all qualities of iron. Even makers of marked bars and makers of wrought iron tube strip are operating much below capacity. Producers of merchant and common grade bars are doing hardly anything at all. In the present state of consumptive demand ironmasters see no reason to interfere with selling prices, it being realised that no accession of demand would be likely to follow upon a fall in prices, given that it were possible for ironmasters to reduce them. Marked bars are quoted £12 per ton at makers' works, Crown bars vary between £9 5s. and £9 15s., according to quality and make, common bars for the nut and bolt and fencing industries are £8 7s. 6d., and wrought iron tube strip is at £10 10s. to £10 12s. 6d. delivered.

Galvanised Sheets.

Makers of galvanised sheets are holding out for £9 10s. per ton for corrugated sheets of 24-gauge, and they are being assisted by an improvement in demand from overseas customers. The market is expanding, however, at only a very moderate rate, and many local mills are short of work. The home trade keeps steady, but its demands are easily met. The request for black sheets is moderate, and here, again, the tendency is towards expansion.

Pressed Steel Motor Bodies.

Some interesting information is contained in the twelfth annual report of Fisher and Ludlow, Ltd., pressings and stampings manufacturers, of Albion Works, Birmingham. The chairman of the company, Mr. R. H. Roberts, states that they regard the future as bright, but issues a warning not to be too sanguine of immediate results. He points out that the firm is one of the very few in this country capable of producing entire pressed steel bodies for the motor trade, and that it now has on hand contracts for this class of work to the value of some £100,000. Without this new type of product it would not have been able to show such a successful year's work. The firm has during the past year purchased the entire control of a business well established in the light steel construction market, and it is now amalgamating this with its own light constructional steel department. Though the trading profit for the year is less than in 1930, it is sufficient for the directors to recommend a distribution of 7½ per cent.

Satisfactory Record.

The year's trading of W. Canning and Co., Ltd., of Birmingham, though it has yielded a profit of £45,443, against one of £52,937 in 1930, can certainly be regarded as satisfactory, and a distribution for the year of 13½ per cent., less tax, should meet with approval. The firm has so much in common with engineering in its many branches, that the views of the chairman, Mr. E. R. Canning, on the trade outlook are of interest. He holds that although it would be optimistic to assume that the crisis is entirely past, there are signs that the worst may be over. There is a more optimistic feeling abroad in trading circles, but heavy taxation is restricting the buying power of the public, and is curtailing the possibility of firms increasing their output of manufactured goods. If it were not for this fact he might, he says, speak even more confidently of the future.

Increased Profits.

James Booth and Co. (1915), Ltd., of Birmingham, have, in face of the depression of trade and keen competition, been able to increase their profits over the previous year, the respective figures being £54,919 and £54,237. A large part of the firm's business consists of the manufacture of brass and copper in various forms, and it has had to face difficult conditions, particularly with regard to the decreased demand for tubes consequent on the depressed state of the shipbuilding and railway locomotive trades. The firm's special aluminium alloys are being applied widely in aircraft, and, to a certain extent, in commercial transport vehicles &c., while the magnesium alloy which it manufactures is now establishing itself for certain specific applications, including aircraft propellers, light furniture, and the various parts of racing motor cycles and cars. The firm's trade is well spread over the various industries of the country, and any general improvement of activity would reflect itself in its turnover.

Obituary.

I have to record the death, which took place on Saturday last, after a short illness, of Mr. Samuel Bayliss, of Tettenhall, Wolverhampton. Mr. Bayliss, who was in his eighty-fifth year, was chairman of the directors of Bayliss, Jones and Bayliss, Ltd., Victoria Works and Monmoor Ironworks, Wolverhampton, a branch of Guest, Keen and Nettlefolds, Ltd. With his brother, the late Mr. William Bayliss, he was associated with the business all his working life. The firm was founded in 1826. Mr. Samuel Bayliss was well known not only in Wolverhamp-

* See *Journal*, Iron and Steel Institute, 1914, Vol. LXXXIX., page 515.

ton, but in the iron and steel and kindred trades of the Midlands, and was highly esteemed. He was for many years a member of the Birmingham Iron Exchange.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Less Money for Roads and Bridges.

A REDUCTION in the estimated expenditure of the Lancashire County Council for the 1932–33 financial year and a decrease of about 6d. in the pound in the county rate are due primarily to important economies on road and bridge schemes, the estimates of the Highways and Bridges Committee of the County Council being lower compared with the previous financial year by rather more than £366,000. Taking into account a loss of nearly £222,000 in Government grants, the net saving to the county in expenditure on roads and bridges will be £144,250. It was explained by the chairman of the Finance Committee at the last Council meeting that the saving is due entirely to the postponement of improvement schemes, the work of maintaining existing roads being carried out as usual. At the beginning of the current financial year the Committee authorised a gross capital expenditure of £740,000 for widenings, reconstructions and tramway reinstatement schemes. At a later date the widening schemes were abandoned, work being confined to the reconstructions and tramway reinstatements. For 1932–33 the gross sum required is estimated at no more than £200,000.

Financing Industrial Development.

Not very long ago Mr. E. Raymond Streat, the secretary of the Manchester Chamber of Commerce, outlined a scheme for providing financial aid for new industrial enterprises and for rendering assistance in the development of existing industries. In a few words, the essence of the scheme is the inauguration of a public trust fund raised by public issue, the administration being in the hands of the Lancashire Industrial Development Council, which would, after careful inquiry, make grants to applicant firms. The matter has since been the subject of joint discussion between the members of the Industrial Development Council and banking interests, but the view of the latter is that the present is not an opportune time for putting the scheme into practical shape. From statements made here during the past week, however, it is understood that the operation of a public trust fund of the nature indicated has been postponed rather than abandoned, and that the scheme will be proceeded with as soon as conditions are more favourable to its success.

Cheaper Gas for Industrial Users.

Mr. C. W. Ward, of Wakefield, in his presidential address at the annual meeting of the Manchester District Association of Gas Engineers last week, put forward a suggestion for the better utilisation of gas-producing plant. Most gasworks, he said, were in a position to produce gas on a bigger scale than they did, and it would pay them to offer supplies to large industrial users at a relatively low rate for special purposes—for example, as a twenty-four-hour load. This system had been adopted to their advantage by a number of gas engineers, but others stated that they wanted increased Parliamentary powers. Mr. Ward suggested to the latter, however, that they were not doing as much as their existing powers allowed them, for much could be done without altering the basis price by means of discounts and other methods. Equal terms must, of course, be given to all under like circumstances; but, said the speaker, under no pricing scheme would it be desirable or businesslike to do otherwise.

A New Salford Bridge.

Work on the construction of a new bridge spanning Irwell-street, Salford, on the London, Midland and Scottish Railway Company's line, started last Sunday, when the three main girders were placed in position. The new structure will be a stronger substitute for an old one, the dismantling of which was completed last week. A feature of the old structure was its support on either side of the street by three huge cast iron pillars. On representations from Salford Corporation that the pillars would interfere with road-widening operations, the railway company agreed to construct the new bridge with a clear 50ft. span, conditional upon the Corporation paying the difference in cost between this form of construction and the renewal of the bridge on the old pillars. The offer was accepted by the Corporation, the cost to it, allowing for the Ministry of Transport grant, being in the neighbourhood of £600.

Non-ferrous Metals.

After the recent declines in the market for non-ferrous metals, prices of all descriptions are a little higher than they were a week ago, but this represents less a real recovery than a slight readjustment following upon the pronounced weakness. The general outlook for the non-ferrous metals is anything but satisfactory, and, notwithstanding the restrictions regarding output that have been put into operation in all sections, supplies in relation to demand are much too top-heavy. The call for tin during the past week has been no more than moderate, but the undertone has been a trifle steadier, and compared with the extremely low prices ruling a week ago, values are about £2 per ton higher. Buying interest in the case of copper continues at a low ebb and the position of the consuming industries in almost all the leading countries shows little indication of improvement. On balance, standard brands of copper are 5s. to 7s. 6d. per ton dearer. The current demand for lead is appreciably smaller than the offers of the metal, and prices are only fractionally above those that were being indicated a week ago. The spelter-consuming industries are affording little support to the market, and here, again, the ground gained represents only a fraction of what has been lost recently.

Iron and Steel.

Quietness continues to characterise most sections of the iron and steel markets. Further contract sales of foundry iron have been reported, but they still fall short of expectations and buying interest develops very slowly, although, apart from a slight tapering off due to the Easter holidays, deliveries to users are not appreciably smaller than they have been of late. Derbyshire, Staffordshire and Cleveland No. 3 iron are quoted at 67s. per ton for delivery to Manchester consumers, Northamptonshire being at 65s. 6d., Scottish foundry at about 86s. 6d., and West Coast hematite at 81s. Bar iron sales are of limited extent, especially of the common grades. Lancashire Crown quality bars are at £9 15s. per ton, and best bars at 10s. more. There is little of interest to report in respect to the steel trade locally, the absence of any weight about the tonnage ordered by Lancashire constructional engineering, boiler-making and locomotive-building firms still being unsatisfactory features. Quotations are on the easy side so far as boiler plates are concerned, offers being at about £8 12s. 6d. per ton; but in other respects the steel market is firm at recent levels.

BARROW-IN-FURNESS.

Hematite.

There is nothing fresh to report about the hematite pig iron market, which continues to be dull and with no signs of improvement at present. The general requirements at home are low and there is no tendency on the part of consumers to place orders for forward delivery to any extent. The output in the district is about as low as it ever has been, and several firms are not producing at all, but are simply selling from the stocks which still exist in considerable quantities yet. The foreign trade is very thin. There have been deliveries abroad, but they have as a rule not gone direct, but have been taken coastwise to Liverpool for transhipment. There is some talk of a change in process at one of the ironworks, and in the course of a week or two it may be possible to give particulars of this new development, which, as regards this district, is quite new. The iron ore trade is very quiet, and, apart from the very light requirements on local account, the outside demand for ore produced in the district is poor. Foreign ore is not being imported to any great extent at present owing to low requirements. The steel market is slack and orders are difficult to obtain. Contracts are held, but the tonnage is not great, and further orders would be welcomed. Shipping continues to be very dull indeed.

SHEFFIELD.

(From our own Correspondent.)

Has the Tide Turned?

DESPITE repeated assurances that Sheffield industry has taken a turn for the better, there is very little evidence at present that trade has begun an upward movement. Here and there one sees signs of growing confidence, and there are more orders for certain lines, but both gains and losses have to be reported this week. In heavy crude steel, output is being maintained, but inquiries are not nearly so numerous. In the lighter and finished sections, individual firms are picking up new business on an increasing scale, much of it diverted from foreign sources, but, on the other hand, the majority of firms in all sections of industry, except strip, tools, and a few lines of cutlery, have been losing ground steadily. The cessation of foreign competition is benefiting makers of electrical accessories, but makers of heavy electrical apparatus are slack after a long period of activity. Unemployment continues heavy in most branches of trade, and the general dearth of orders may mean a prolonged Easter stoppage. The scrap market, usually regarded as a fair index of trade conditions, continues quiet, with an easier tendency of prices. The market for ferro-alloys is more or less stagnant, as the result of pre-tariff stocking, and a reduced demand for high-speed steel is suggested by the low consumption rate of tungsten. Restrictions on the export of money from various countries are holding up a considerable amount of foreign trade.

Cutlery and Plate.

The home trade in table cutlery has fallen extremely flat this week, less than the usual quantities having been bought by shopkeepers for the Easter season sales. The recent boom in surgical instruments, scissors, cheap pocket knives, tool knives, and small cased articles is also less pronounced, although there are some substantial special contracts for ship, coupon, and bazaar goods. Many distributors are changing over from German to Sheffield goods, but they do not take very kindly to the higher prices, hence a good deal of the business offered is scarcely remunerative. Sales of silver and best plated hollow-ware dropped to a new local record for the first two months of the year, but business in silverware is showing signs of revival, and the month is likely to finish better than it began. Business in hand tools continues to expand and exports are increasing.

Foreign Firms and Sheffield.

Negotiations are proceeding with a view to certain foreign firms producing their specialities in Sheffield. Such a movement on the part of German firms is being hindered by the restrictions on taking capital out of that country, but several plans to make German goods in local works under licence bid fair to mature, though the prospect is not welcomed by local firms.

Hull Queen's Dock Estate.

Details are now available of the lay-out of the Queen's Dock estate at Hull, one of the greatest improvement schemes undertaken by the Corporation in recent years, which has now been approved. The Corporation acquired the dock from the L.N.E.R. Company for £117,000 and part of the agreement was that the Corporation should undertake three-quarters of the filling in, the work to be completed within three years. Dredgings equivalent to 266,000 cubic yards have been deposited, the company having completed its part of the filling in half the time allowed, an achievement on which it was complimented by Alderman Sir Alfred Gelder, the originator of the scheme, and the Committee. Within six months a road across what was water space will have been completed, connecting Grimston-street with the south side of the dock. This part of the work is to be carried out as speedily as possible, owing to the facilities it will afford the fire brigade to reach the Old Town without having to traverse the present circuitous route across bridges. Work on the demolition of Monument Bridge has been started. The central portion of the lay-out provides for a boulevard, 100ft. wide, planted with trees, each side being laid out as pleasure gardens. Between the gardens and the nearest buildings, space is available for the parking of cars, 250 on each side. On the western end will be a traffic "roundabout" to relieve the congested state of Savile-street and King Edward-street. Sites have been reserved for buildings on the north side of the estate. At the east end of the estate it is proposed to erect at some future time administrative offices for the whole of the city's educational activities, and a site has been reserved for a new technical college with an approach from the boulevard. The lay-out has been planned in order to allow of 75 per cent. of the area being an open space. It is not proposed to proceed with the general scheme until financial conditions are more favourable. The Committee has been informed of a grant of 60 per cent. of the estimated cost of roadworks and the removal of the bridge by the Ministry of Transport, the grant not to exceed £6240.

Use of Gas in Industry.

It was declared a year or so ago that the use of gas for reheating slabs and billets for rolling into sheets was not a practical proposition. To-day, however, not only is gas being used successfully for this purpose, but experience is proving that no other fuel is so flexible, and easy of control or so capable of producing such uniformly satisfactory results. Realising the growing importance of gas in connection with the city's industries, the Sheffield Gas Company has appointed an industrial research chemist and has opened and equipped a physical, chemical, and metallurgical laboratory for the purpose of carrying out research work on materials and processes in connection with Sheffield trades. The demand for town's gas for industrial heating purposes continues to increase, and the company recently fixed a meter capable of registering gas at the rate of 50,000 cubic feet per hour, for the purpose of supplying furnaces, one alone of which will consume gas at the rate of 25,000 cubic feet per hour.

Sheffield Steel Research.

Facts are forthcoming from Dr. W. H. Hatfield, the Sheffield metallurgist, concerning the research carried on in Sheffield in recent years to produce steels of great strength when submitted to high temperatures. He says it is now possible to measure the stretch or expansion of steel to less than one-quarter of a millionth of an inch, and to keep its temperature steady during the tests to within a tenth of a degree for long periods by means of sensitive machinery. As a result of these experiments, cheaper and better steel of this kind is now being produced. One of the principal features of these new heat-resisting steels is that they do not scale at high temperatures. The evolution of steel tubes which can be used at red-heat temperatures is another practical result of research. These tubes have proved of immense utility for aeroplane exhausts.

Humber Bridge.

The Minister of Transport is to be approached by the Hull Corporation with a view to ascertaining the Government's decision in the matter of a grant towards the cost of building a bridge across the Humber. The estimated cost of the bridge is £1,750,000, of which the late Government undertook to provide 75 per cent. The Bill authorising the construction of the bridge came before a Committee of the House of Commons, and was approved, although, as the result of opposition by Goole, the Aire and Calder Navigation, the railway companies, and other interests affected, the Chairman pointed out the necessity for the construction of training walls in the river, which would add very considerably to the cost. The political crisis arose before the Bill had time to come before a Committee of the House of Lords. A resolution was passed in the House of Commons keeping it alive, and the promoters gave an undertaking not to take steps to bring it before the House of Lords Committee before Easter. The time has now arrived for them to decide what their action is to be. Pledges have been given that the work will not be gone on with if the Government grant is not forthcoming. The general expectation is that the Minister will say that the present Government cannot supply the money.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal Strike Threat.

THE vexed question of non-unionism in the mines has taken a grave turn in the county of Durham, the Ryhope miners, numbering about 2000, having decided to take strike action. They made their decision without consulting the headquarters of the Durham Miners' Association—a departure from the usual procedure. The Association, however, is to consider the whole question of non-unionism at an early date. Instituted four months ago, the campaign for 100 per cent. unionism has spread like wildfire through the county coalfield, with strong encouragement from the Miners' Association. The plan is to work by individual lodges, so as not to force a general stoppage. Wearmouth, Hylton, and Silksworth lodges have got non-unionists into the union without a clash with

the management. Equal success, however, did not attend the efforts at Ryhope. The dispute took on a serious aspect when notices were given to 120 men and boys employed in the West Pit. These notices terminated on Friday last. All the affected employees are members of the Ryhope Miners' Lodge, and the lodge officials suggested to the colliery management that non-unionists, of whom there are seventy at the colliery, should be dismissed and their places filled by members of the lodge. The management refused to discriminate between union men and non-unionists. The men thereupon decided to hand in fourteen days' notice. Most of the men outside the union are men who were once in the association, but their membership has lapsed through non-payment of contributions—in most cases owing to unemployment. Some have been out of the association since the 1921 stoppage, and either have not had the means or the desire to rejoin the union. The executive of the Durham Miners' Association has requested the delegates of the various lodges throughout the county to submit resolutions on the question for the consideration of a special meeting of the Council early in April.

Cleveland Iron Trade.

Although business in the Cleveland iron trade still leaves much to be desired, there are, nevertheless, unmistakable signs of improvement. Indeed, it is a long time since the atmosphere was so hopeful. Confidence in steady trade improvement is rather more marked. Both the home and overseas demands are expected to expand after the Easter holidays. Makers have only light stocks and are determined not to enlarge output until demand fully warrants such action. They are in a sufficiently strong statistical position to adhere firmly to their minimum prices, which, except for supply to firms in Scotland, stand at 61s. for No. 1 foundry, 58s. 6d. for No. 3 G.M.B., 57s. 6d. for No. 4 foundry, and 57s. for No. 4 forge. To consumers in Scotland substantial price concessions are offered in the hope of successfully competing with sales of Indian and Midlands iron.

East Coast Hematite.

There is little change of note in the condition of things in the East Coast hematite pig iron trade, and the market continues on the quiet side. Consumers are still showing little disposition to place orders for metal, except for small tonnages to cover their immediate needs. Mixed numbers are freely offered at 63s. 6d. and No. 1 quality at 64s.

Iron-making Materials.

Consumers of foreign ore have very heavy stocks and have extensive contracts made, but are not taking deliveries. Sellers realise the futility of attempting to do business under existing conditions and are off the market. Best Rubio ore is nominal at 16s. c.i.f. Tees. Good medium blast-furnace coke is weak at 16s. 6d., delivered at the works.

Steel Rail Orders Placed.

The steel trade has received an impetus this week by the placing of steel rail orders by the London, Midland and Scottish Railway Company, Ltd. Three Teesside firms share in the contracts for 40,000 tons—Dorman, Long and Co., Ltd., the Cargo Fleet Iron and Steel Company, Ltd., and Pease and Partners, Ltd. The London, Midland and Scottish Railway Company have also placed a contract worth something like £30,000 with Dorman, Long and Co. for several railway bridges to be built in the Peak District. Although the rail contracts are smaller than usual, in view of the economy ruling, they are very welcome. Conditions generally in the steel trade are improving. Foreign competition is not so keen, and home consumers are coming forward more freely for supplies of semis. Prices are unchanged.

The Coal Trade.

A strong demand for best bunkers and a sustained inquiry for large Northumberland steams have been the outstanding feature of an otherwise dull coal market. Some of the special classes of bunkers have been unobtainable. April prospects are encouraging for steam coals, and rates of exchange and other advantages are maintaining a steady run of bunker orders for the Tyne. Durham county has suffered from the prolonged industrial depression and the mild winter. These factors have caused a greatly lessened consumption of coking and gas coals, chief among the products of the mines of the county. Spring and the light season is here, and so far as gas coals are concerned, stocks will have to be appreciably reduced before further purchases are made. Another reduction in the number of miners employed in Durham county has taken place, and the general outlook for the summer months is not encouraging. Bunker coal continues to be the main centre of activity in Durham classes, and sellers are reserved, offering only in moderate volume at firm prices—best at 13s. 9d. to 14s. and seconds at 13s. 3d. Gas coal output is severely limited. Best qualities are quoted freely at 14s. 6d., with secondaries at 13s. 6d. Prime Wear are also rather quiet at 15s. Coking screened remains a weak trade at 13s. to 13s. 9d. Coking small movement is rather more active, but ample supplies offer at 12s. 6d. to 13s. 3d. Recent firmness in the Northumberland steam coal trade is fully maintained. Fitters report good booking over the Easter period, and owing to reductions in output through holiday causes the prices asked are firm in tone. For March shipment the minimum direct price is 13s. 9d., this figure being discountable through contractors. Next month's prospects are fairly good, values indicated remaining at 13s. 6d. to 13s. 9d. Tyne prime, prompt or forward, are in moderate supply, and steady at 13s. Wear prime steams are also well booked, being quoted firmly at 15s. for large and 12s. for small. Cokes are marked by an all-round easy tone. Occasional cargoes are despatched to the Continent and the Baltic, but they are small contributions to the need there is for a more rapid clearance of output. The coke nuts trade to the United States has fallen away entirely, and in most parts of Scandinavia there are said to be large supplies of foundry and gas cokes for industrial or central heating purposes. Durham ovens are reported to be making more coke than can be disposed of, and there is likely to be a curtailment of output. Patent ordinary is plentiful and offered at 15s .3d. to 16s., while higher grades are 17s. to 18s. Gas coke is unchanged at 18s. 9d. to 19s. Coke nuts range from about 18s. to 19s.

SCOTLAND.

(From our own Correspondent.)

Steel.

BUSINESS in the steel trade is, if anything, quieter. Demands for heavy steel are on very meagre lines, and particularly in respect to shipbuilding material, in which the poverty of specifications reflects to some extent the poor state of affairs at the Clyde shipyards. The demand for structural material also is rather disappointing. Steel sheet makers are still comparatively busy in the lighter gauges. A certain amount of business has been booked for shipment to Canada, and it is expected that business with the Dominion will show a decided improvement this season. Galvanised sheets have a moderate turnover, and the enquiry is fairly well maintained. Tube makers are quieter and no change is expected until the position as regards the Cartel is more definite. Prices are all unchanged.

Iron.

The market for bar iron, re-rolled steel bars, and pig iron is dull. Re-rolled steel bars are still quoted about £6 5s. home and £6 2s. 6d. per ton export, but makers have continued to show a tendency to indulge in price-cutting to induce business. Demands for pig iron are very light, and the output from the six furnaces in action is quite equal to all calls, more especially as considerable quantities still arrive in this district from England and India. Last week's consignments amounted to 2750 tons from Calcutta and 900 tons from Millom. Prices are unchanged.

Scrap.

There has been very little movement in scrap of late, and prices have declined to 37s. 6d. for heavy steel, and from 50s. to 52s. 6d. per ton cast iron machinery, a drop of 2s. 6d. per ton in each case.

Coal.

There has been a little more inquiry for shipment during the past week, and the possibility of doing forward business does not seem quite so remote. Meanwhile, exporters can only secure forward business by discounting colliery prices, which are still considerably in excess of buyer's ideas, but shippers are not prepared to take the necessary risks at present. All descriptions of Scottish fuel, with the exception of Lanarkshire splints and Fifeshire treble nuts, are easily obtainable at current prices. During the week the Aarhuus Electricity Works purchased 20,000 tons of Lanarkshire washed singles at 13s. 6d. per ton c.i.f. for May–January shipment, and the Danish Sugar Works placed an order for 6000 tons of Scottish singles on the basis of 13s. 3d. per ton c.i.f. Copenhagen for April–June shipment. The Swedish Western Railways have invited tenders for 16,000 tons locomotive coal for July–October shipment, such tenders to be lodged by April 1st. It is understood that Fifeshire collieries are prepared to supply first-class steam at 12s. 6d. per ton. It is also reported that the Preston Electricity Works have arranged several trial cargoes of Ayrshire nuts. One cargo has already been despatched.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THERE is not much of special interest so far as the steam coal section of the industry is concerned, inasmuch as the conditions appear to be stationary, which, in other words, means that they have not in any way improved. In years gone by the near approach of a holiday period was synonymous with a burst of activity. Coal prices not infrequently improved, and rates of freight for prompt steamers advanced; but such is not the case nowadays. It is true that a few fresh orders have come along for France, but this fact has not apparently strengthened the market, which remains comparatively quiet and without price fluctuation. According to the returns of the Great Western Railway Company, shipments of coal and coke last week came to 410,445 tons, which was rather disappointing, as this figure was 46,855 tons below the quantity for the preceding week and 53,292 tons less than the total for the corresponding period of last year. Still the reduction was not at all surprising, seeing that at the end of the week the number of vacant loading berths reached the total of thirty-six. The returns for this week and next cannot, of course, be expected to be good, in view of the holidays and the suspension of production and shipping operations. The position from the loading point of view on Monday was that there were twenty-six vacant berths, but ten steamers were waiting, of which six were at Swansea, which indicates that the position so far as anthracite coal is concerned was not at all unsatisfactory. Recent activity in the chartering line cannot be said to have been brisk, though a few of the leading Admiralty coals are reported to be comfortably stemmed. Not only is current business on a quiet scale, but contract operations are slow. As was feared, the order for 75,000 tons of steam coals, consisting of two-thirds large and one-third smalls for the Brazilian Central Railways for early delivery at Rio de Janeiro has been lost to South Wales. Every effort was made to secure this business, but there is a limit to which exporting firms can go, not only as regards the price, but what was of very great importance in view of the amount of money which is still owing to local firms, the terms of payment. The Germans have secured the coal order by taking cargoes of coffee in return. The German Government will distribute the coffee among German importing merchants for cash, while the Brazilian Government will collect the money for the coffee exporters. One other inquiry on the market is for about 13,000 tons of steam coals for a Portuguese Railway to be delivered at Oporto over a period of about twelve months from May next. This business is on a c.i.f. basis.

Safety in Mines.

Mr. Isaac Foot, the Secretary of Mines, paid a visit of inspection to South Wales last week, and on the Thursday put in an appearance at the annual meeting of the South Wales Institute of Engineers at Cardiff. He also presided at an important conference at Swansea on Saturday on Safety in Mines, when there was a gathering fully representative of the coal-mining industry of West Wales. At this conference Sir Henry Walker, his Majesty's Chief Inspector of Mines, strongly advocated the increased use of steel in the form of arches for the support of roads, and in the shape of props for the support of the faces. Mr. Evan Williams, President of the Mining Association of Great Britain, expressed the opinion that the use of steel was going to improve their position with regard to accidents from falls of roof, and on the question of lighting said that there was no doubt that a better lighting at the face was directly conducive to safety of work. He took the opportunity of urging upon all in control to give the most serious attention to the substituton of high candle-power lamps for those now in use. Major H. M. Hudspeth, mining engineer to the Safety in Mines Research Board, advocated the use of protective equipment and the wearing of hard hats, gloves and goggles, his contention being that if that were done the 150,000 accidents that happened yearly in this country would be reduced to something like 100,000.

Tin-plate Trade Wages.

Six months' notice to terminate the existing sliding scale agreement which governs the wages of the operatives in the tin-plate industry of this district has been given by the employers. No reason is assigned for this step. The existing agreement was reached three years ago, and it substituted one under which the wages were governed by the selling price of tin-plate bars, whereas the basis under the existing arrangement is the selling price of tin-plates per box, less allowances for tin and steel bars above a certain figure. Another condition is that during the currency of the agreement no fresh claims could be made on either side, which has had the effect of keeping the industry free from trade disputes.

Current Business.

There has been very little fresh business on the steam coal market for prompt loading. Dry coals and sized qualities have been moving off fairly well, but other descriptions have been offered freely for loading in any position. Prices have not undergone any change, and remain at the minima. Patent fuel and coke have displayed no alteration, but pitwood has continued to meet with a poor demand, and prices are on the weak side at 20s. to 21s. 6d.

CATALOGUES.

MUREX WELDING PROCESSES, Ltd., Ferry-lane Works, E. 17.—"Handbook for Electric Welders."

N. NAYLOR AND SON, 17, Goree Piazzas, Liverpool.—"Case Hardening: What to Use, How to do it."

LIPTAK FURNACE ARCHES, Ltd., 38, Victoria-street, S.W. 1.—A technical bulletin on "Gako" burners for gas fuel.

SHEFFIELD STEEL PRODUCTS, Ltd., Templeborough Works, Sheffield.—New international price list for S.S.P. files.

EDGAR ALLEN AND CO., Ltd., Sheffield.—Publication on the Edgar Allen-Allis-Chalmers centrifugal vibrating screens.

B.E.N. PATENTS, Ltd., 92, Tottenham Court-road, N.W. 1.—A catalogue giving illustrated details of spray paint plant.

MUSKER AND WRIGHT, 151, Upper-street, N. 1.—A leaflet illustrating and describing the "Reliance" drill grinding jig.

BEYER, PEACOCK AND CO., Ltd., Manchester.—An eighty-page brochure on "Beyer-Garratt" articulated locomotives.

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—"Immaculate" stainless and heat-resisting steel folder.

SIR WM. ARROL AND CO., Ltd., Glasgow.—A production for 1932, giving the firm's hydraulic and mechanical engineering products.

BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, E.C. 4.—Technical data on overhead transmission lines.

IMPERIAL CHEMICAL INDUSTRIES, Ltd., Millbank, S.W. 1.—"Wire," a booklet dealing in detail with the manufacture of non-ferrous wires.

WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., 82, York-road, N. 1.—Pamphlet 116 on metal rectifiers for electrical instruments.

PREMIER GAS ENGINE COMPANY, Ltd., Sandiacre, near Nottingham.—A number of catalogues on the Crossley-Premier horizontal heavy oil engines.

BROOM AND WADE, Ltd., High Wycombe.—A catalogue containing illustrated details of "Broomwade" single and multi-stage double-acting air compressors.

DUNLOP RUBBER COMPANY, Ltd., St. James's House, St. James's-street, S.W. 1.—"Dunlop 60 per cent. Latex," describing the technique of preparing Latex.

WAILES DOVE BITUMASTIC, Ltd., Collingwood Buildings, Newcastle-on-Tyne.—Particulars of a new material, "Bituplastic," for waterproofing, bonding, flooring, roofing, &c.

JOSEPH BOOTH AND BROTHERS, Ltd., Rodley, Leeds.—Thirty-second edition of the firm's catalogue of cranes, battery trucks, and battery locomotives, with supplementary data and tables.

FRANCIS MORTON AND CO., Ltd., Garston, Liverpool.—An illustrated folder on steel road and railway bridges, steel-framed buildings, and all descriptions of constructional steel-work.

UNITED STEEL COMPANIES, Ltd., 17, Westbourne-road, Sheffield.—A book on "Stocksbridge" alloy steels, containing comprehensive data on each steel, giving the composition, relative price, and specifications filled.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 21/–
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	16/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 3 6	3 3 6
No. 1	3 4 0	3 4 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (*a*) 4 0 6 (*b*) 4 5 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	10 0 0	—
Best Bars	10 10 0	—
Double Best Bars	11 0 0	—
Treble Best Bars	11 10 0	—
Lancs.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 5 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0 to 10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.	10 15 0	10 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 12 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	5 7 6 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	16/–
Block Tin (cash)	127 15 0
„ (three months)	129 10 0
Copper (cash)	32 16 3
„ (three months)	32 18 9
Spanish Lead (cash)	12 0 0
„ „ (three months)	12 2 6
Spelter (cash)	12 8 9
„ (three months)	12 16 3
Manchester—	
Copper, Best Selected Ingots	36 15 0
„ Electrolytic	38 0 0
„ Strong Sheets	66 0 0
„ Tubes (Basis Price), lb.	0 0 10
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	14 10 0
„ Foreign	12 10 0
Spelter	13 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/4 per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£26 8 6	7/–
„ „ 6 p.c. to 8 p.c.	£23 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£23 0 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£40 0 0	10/–
„ „ „ 1 p.c. carbon	£55 0 0	12 –
„ „ „ 0·70 p.c. carbon	£57 10 0	13/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	3/1 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/– per unit	
„ „ 75 p.c.	£17 15 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
„ „ Ell	14/3
„ „ Splint	14/– to 16/–
„ „ Trebles	12/6
„ „ Doubles	10/9
„ „ Singles	9/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	16/6
„ „ Trebles	12/6
Fifeshire—	
(f.o.b. Methil or Burnt island)—Steam	11/6 to 12/6
Screened Navigation	16/6
Trebles	12/6 to 13/6
Doubles	10/6
Singles	9/–
Lothians—	
(f.o.b. Leith)—Best Steam	11/9 to 12/–
Secondary Steam	11/6
Trebles	11/6 to 12/–
Doubles	10/6
Singles	9/6

(8) N.W. Coast— ENGLAND.

Steams	21/9
Household	32/6 to 51/8
Coke	20/6 to 23/–
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–

Sheffield—	Inland.
Best Hand-picked Branch	26/6 to 27/6 —
South Yorkshire Best	22/– to 23/– —
Derbyshire Best Bright House	22/– to 23/– —
Screened House Coal	19/– to 20/6 —
Best Screened Nuts	17/– to 18/– —
Small Screened Nuts	14/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Smalls	5/– to 6/– —
Blast-furnace Coke (Inland)	12/– to 13/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/3
Pitwood (ex ship)	19/6 to 21/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 43/6
Nuts	40/– to 42/6
Beans	28/6 to 32/6
Peas	18/6 to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals:	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate; Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Seconds, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Price Stabilisation.

THE concentration of interests, whereby the production of pig iron and steel is limited to requirements, and sales are centralised, is having the effect of hardening prices on the home market, and during the past week hematites have been controlled in this way by the recently revived Office Statistique des Produits Métallurgiques, or O.S.P.M. as it is generally called, which limits the output of pig iron producers and fixes prices. Raw iron and steel, now being stabilised, and mill and forge owners having combined in the same way to regulate production and maintain prices of merchant bars and joists, the situation has much improved, although it will still be necessary to bring in some outside firms before the combination is quite effective. This has been done at a time when orders are beginning to come in on account of the programme of national and relief works, and there is an impression that the accelerated downward movement has been checked to a certain extent, but as the contracts are, in many cases, offered at low prices the margin of profit to constructional engineers and wagon builders is likely to be reduced. There is necessarily keen competition for the work amongst manufacturers whose production facilities were increased so considerably after the war that they can hardly expect again to find full employment, and it has become a serious matter to know what to do with this superfluous plant in the future. While the French are taking care of their home market the international situation is becoming worse, and the only hope lies in the reconstruction of the Steel Cartel, which must be put into operation if prices are to be stabilised and some sort of confidence restored, but in view of the difficulties in the way of forming the Cartel the German Government has decided, in the event of negotiations failing, to impose a quota system on the importation of iron and steel products into Germany. It is hoped that this decision will have the effect of clearing away the obstacles to the reconstitution of the Cartel.

Machinery and Tool Imports.

During the four months from March 1st to June 30th import quotas have been fixed for a number of classes of machines and tools, as well as for cold-rolled steel strip, and it is remarkable to observe how Germany is favoured in the distribution of the quantities to be imported. In the following totals the quintal is equal to 1·97 cwt. The imports of cold-rolled steel strip are limited to 4249 quintals, Germany supplying 1730 quintals, Belgium 1181 quintals, and Great Britain 949 quintals. Of 3876 quintals of cold-rolled steel strip hardened, varnished, nickeled, &c., Germany is allotted 3358 quintals, Switzerland 248 quintals, and Great Britain 150 quintals. The imports of machine tools and shearing machines are restricted to 5759 quintals, of which Germany will supply 4000 quintals and Great Britain 755 quintals. The quantity of pneumatic riveting and other tools authorised to be imported is 164 quintals, and of this amount the United States is allotted 77 quintals, Belgium 36 quintals, and Germany 27 quintals. Woodworking machinery is limited to 1623 quintals, of which amount Germany will supply 1174 quintals. "Other machine tools" can be imported to the extent of 3157 quintals, and here again Germany takes the lead with 1467 quintals, followed by Great Britain with 629 quintals. Of machine parts and transmission gears Germany will supply 7000 quintals out of a total of 7817 quintals, and Great Britain 230 quintals. The value of drills, taps, reamers, and tools for pressing and stamping is fixed at 2,631,286f., and of this quota Germany is allotted 1,286,651f., the United States 771,868f., and Great Britain 273,909f. Germany takes more than one-half of the 3074 quintals of metal saws, files, foundry tools and tools of various kinds employed in the machine shop, and 333 quintals out of the total of 619 quintals of spanners. These allotments are based upon the imports from the respective countries during a preceding period. They do not, of course, satisfy either British or American importers, and representatives of American machine tool makers recently interviewed the Minister of Commerce and informed him of the difficulties that might arise if importers were not consulted before the quotas were fixed.

Paris Gas Supply.

As with all other public services, the Paris Gas Company originally obtained a concession from the municipality for a number of years, at the end of which time the undertaking would revert to the city of Paris, and when that occurred several years ago the Municipal Council took over the business, which it farmed out to the existing company. It is a municipal enterprise employing the company to run it, and the profits are shared by the company and the Council. The municipality started by doing things on a big scale. It modernised and extended the gasworks at a cost of something like 1000 million francs, but the increased capacity of production has been followed by a decline of consumption, which represents only about one-half of what the gasworks can supply. The profits to the municipality are less than 40 per cent. of what they were before the war, as the result partly of the increased wages, which have been nearly doubled, and of the heavier fiscal charges. The cost of gas for lighting was raised, at the time of the slump of the franc, to 1f. per cubic metre, ostensibly as a temporary measure, but it has remained at that figure ever since, and the heating value of the gas has been reduced by the addition of water gas. Consumers complain that they are treated unfairly in being required to pay more for a gas of poorer quality, and are agitating for a reduction of price and the carrying on of the business on commercial lines instead of its being regarded merely as an instrument in municipal finance. The matter was discussed last week by the Council, when it was stated that a reduction in the price of gas was impossible without upsetting the municipal budget. Against the claim that coal is cheaper, it was stated that the values of by-products had depreciated, but that argument does not alter the fact that cheaper gas would be followed by an increased consumption and probably greater aggregate profits. A comparison is made between the municipally controlled gas supply and the distribution of electricity by companies, which is all to the advantage of the latter.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

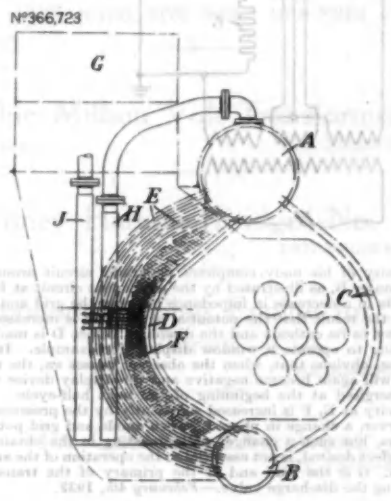
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

366,723. February 6th, 1931.—SUPERHEATERS FOR WATER-TUBE BOILERS, J. Johnson, Green Shutters, The Highway, Sutton, Surrey.

This invention is concerned with the application of superheaters to the Johnson type of water-tube boiler, which has already been described in our columns, and aims at the even distribution of the steam throughout the superheater and the provision of the maximum amount of heating surface in the minimum of space. The boiler has two drums A and B, a double bank of curved water tubes C on the right, a treble bank of

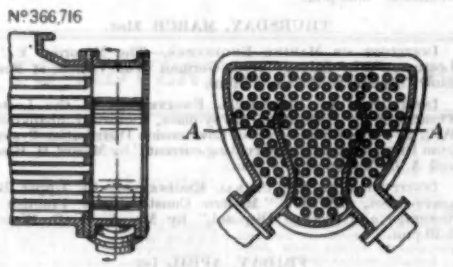


tubes D on the left, and a further multiple bank of tubes E, also on the left, but spaced away from the bank. The intervening space provides accommodation for the horizontal superheater tubes F. The uptake is shown at G. The superheater tubes are made up in groups of, say, six hairpin bends, each group being connected with the saturated steam header H and the superheated steam header J individually. It is, consequently, possible to remove any faulty tubes and to bridge them over without disturbing the other tubes of the superheater.—*February 11th*, 1932.

CONDENSERS AND FEED-WATER HEATERS.

366,716. February 3rd, 1931.—SURFACE CONDENSERS, *W. W. Triggs*, 58, *Lincoln's Inn Fields, London, W.C.* 2.

It is suggested in this specification that the corrosion of the tubes of a surface condenser may be caused by the froth, containing air, which accumulates in the upper part of the circulating water boxes. This froth, it is explained, is carried into the tubes

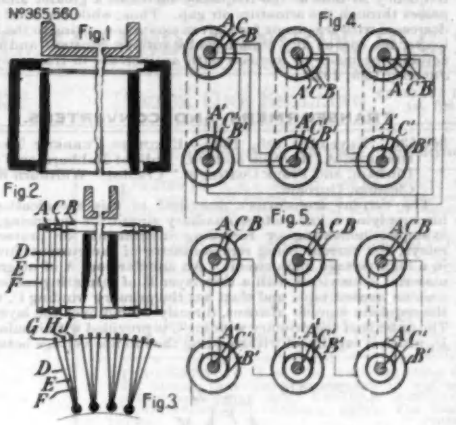


and causes the corrosion. For this reason, the inventors provide the baffles, in the water box, shown at A A, which ensure that the cooling water will be well distributed, with no likelihood of stagnant pockets. At the same time the velocity of the water is maintained throughout its path, so that there is no tendency for a reduction of pressure, and a consequent liberation of entrained air.—*February 11th*, 1932.

DYNAMOS AND MOTORS.

365,560. October 15th, 1930.—DYNAMO-ELECTRIC MACHINES, The Brush Electrical Engineering Company, Ltd., of Falcon Works, Loughborough; and Charles Cecil Sutton, of the same address.

This specification describes an extra H.T. ring winding for A.C. dynamos and motors, and the object is to provide a winding which will shorten the overhang considerably, simplify the end connections, and allow of an arrangement of connections that will give ample distance between points of maximum potential. The drawings illustrate three methods of carrying out the invention, Fig. 1 being a diagrammatic view assumed to be a section taken axially of the stator of an alternator, with concentric conductors carried the whole way round the stator in the well-known way of a ring winding, there being only one layer of connections at each end of the machine. In Fig. 2 a concentric conductor A B C is arranged on the inner periphery of the stator and a similar concentric conductor on the outer periphery, but the end connectors are split up into three groups, the group B nearest the core consisting of conductors of the lowest voltage. Fig. 3, which is a cross section, shows a concentric conductor only on the inner periphery, separate conductors, D E F being used in the end winding and other separate conductors G H J on the outer periphery. The way in which the individual conductors are connected in series through the conductors in other slots will be understood from Figs. 4 and 5. Fig. 4 is a diagrammatic view of the connections of concentric conductors on the outer and inner periphery of the stator, it being assumed that there are three slot conductors per pole per phase. A C B are the conductors on the outer periphery and A^1 C^1 B^1 the conductors on the inner periphery, the front end connectors being shown in full lines and back end connectors in dotted lines. This arrangement, as will be obvious,

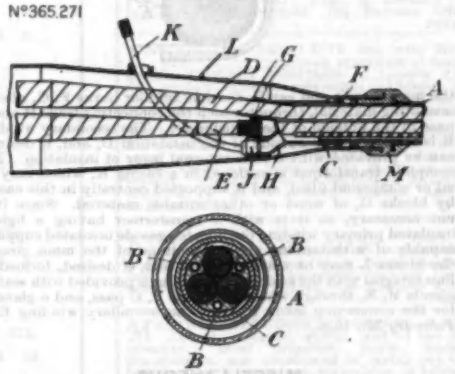


is applicable to either of the examples illustrated in Figs. 1 and 2. Fig. 5 is a similar diagrammatic view showing how the series connection may be effected in the example such as that of Fig. 2, where the end connectors are split up into groups.—*January 15th*, 1932.

TRANSMISSION OF POWER.

365,271. December 16th, 1930.—OIL-FILLED ELECTRIC CABLES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The object of this invention is to provide a method of connecting oil-filled cables without permitting the escape of oil from the fillers between the cores or from the drainage pipes in the fillers. A is the cable sheath of a multi-core cable, and B is a drainage pipe in the fillers between the cores. In order to be able to connect the cable end with another cable without oil running out of the drainage pipe and out of the filler spaces, a closing cap C is arranged over the cable sheath, and has a number of mouthpieces corresponding to the number of cable cores. In the upper drawing only the tubular mouthpieces serving for

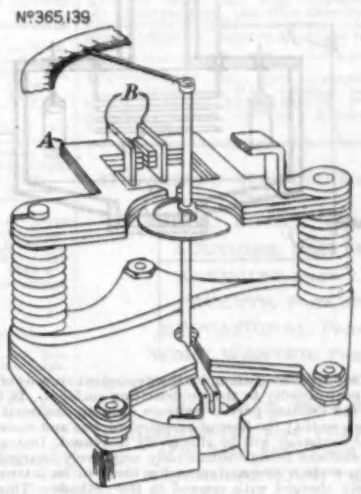


the passage of the cores D and E are to be seen. The closing cap is connected in a pressure-proof and oil-tight manner with the lead jacket of the cable by a soldered joint F. The ends of the tubular mouthpieces of the closing cap C, which serve for the passage of the cores, are packed by a binding of cord G in order to prevent the premature leakage of oil from the cable into the muff. The layers of cord are partly wound over the end of each mouthpiece and partly upon the core. H is an additional aperture on the closing cap which is closed off by a sealing stopper J. In order to enable this sealing stopper to be opened after completing the muff connection, a flexible stem K is attached to the sealing stopper and is led out of an aperture provided in the muff casing L, connected by a wiped joint M with the lead sheath.—*January 21st*, 1932.

MEASURING AND TESTING INSTRUMENTS.

365,139. September 13th, 1930.—ELECTRIC MEASURING INSTRUMENTS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

One of the objects of this invention is to compensate alter-



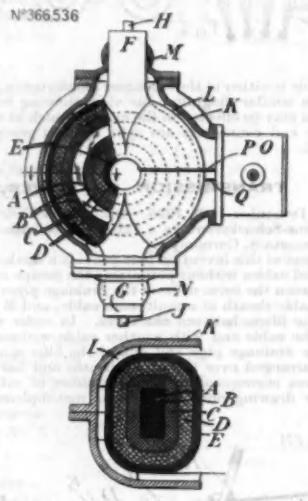
nating current instruments for variations in frequency, and another object is to provide a magnetically damped instrument of improved design. The frequency compensation of the instru-

ment is accomplished by varying the relative magnitude of the total flux allowed to cross the armature air gap. A certain amount of flux is shunted around the armature air gap through the poles A. Owing to the reactance effect of the short circuited conductors B, in which current is induced by the shunted fluxes, the shunted flux is choked back to an extent varying with the frequency so that as the frequency increases a greater amount passes through the armature air gap. Thus, while the total flux decreases with frequency for a given excitation, owing to the iron losses, the torque flux remains substantially constant and may actually be made to increase with an increase in frequency.—*January 13th*, 1932.

TRANSFORMERS AND CONVERTERS.

366,536. November 5th, 1930.—ELECTRIC CURRENT TRANSFORMERS, A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, Durham, and Frank Coates, of "Cranlea," Whitburn-road, Cleadon, Durham.

The current transformer described in this specification is for supplying a low-voltage auxiliary circuit for energising, for example, indicating or recording instruments or protective relays, the current being representative of the current flowing in a high-voltage main circuit. An annular core A of magnetic material is provided with a thin layer B of insulating material, such as treated tape, and then has the primary winding C, with the requisite number of turns, directly wound over the layer B. The outside of the primary winding C is provided with insulation D, which is capable of withstanding the full line voltage between

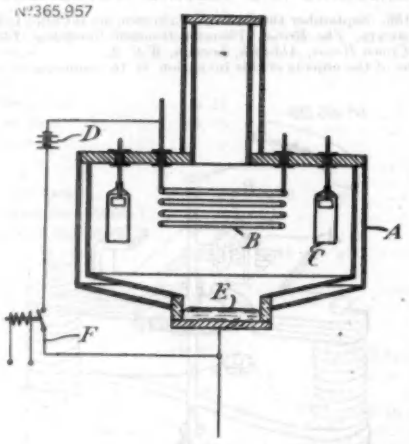


the main circuit and earth, and has tubular horns F, G, also of insulating material, through which the connecting leads H and J pass to the outside of the transformer. The secondary winding E is wound on the outside of the insulation D, and, if desired, can be provided with a thin external layer of insulation. The complete transformer is enclosed in a casing K, which may be oil or compound-filled, and is supported centrally in this casing by blocks G, of wood or other suitable material. Since it is not necessary, as it is with a transformer having a lightly insulated primary winding outside, to provide insulated supports capable of withstanding the full voltage of the main circuit, the blocks L may be made of metal and, if desired, formed as lugs integral with the casing. The casing is provided with sealing glands M, N, through which the horns F, G pass, and a gland O for the connecting leads P, Q of the secondary winding E.—*February 5th*, 1932.

MISCELLANEOUS.

365,957. June 8th, 1931.—MERCURY VAPOUR RECTIFIERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

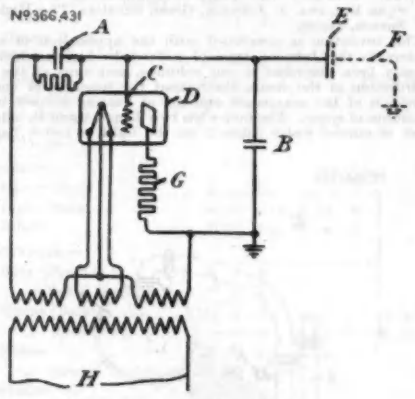
A mercury vapour rectifier constructed in accordance with this invention has a double water-cooled metal casing A and a cooling water coil C disposed within the annular group of anodes C. The cooling coil is supplied from the source of voltage D, with a potential which is negative with respect to the cathode E. As the metal surfaces in the interior of the rectifier, which act as cooling and condensation surfaces for the mercury vapour, are negatively charged with respect to the cathode, a dependent flow of positive mercury ions to these surfaces is established. By this means the path for the neutral mercury molecules to these condensation surfaces becomes free, and finally the mercury



vapour will be carried along by the dependent current of positive ions in part directly to the condensation surfaces. In this way, besides the existing partial pressure drop an electrical drop is produced, so that the flow of mercury vapour and consequently the heat exchange will be effectively increased. Instead of the cooling surfaces being continuously negatively charged, it will suffice in certain circumstances for them to be intermittently negatively charged with respect to the cathode. This can be effected, for instance, by switching arrangements F, which operate automatically in dependence on the load on the rectifier, the voltage, the vacuum, or vapour pressure in the interior of the rectifier or in dependence on the temperature of the rectifier or of the cooling water. The value of the negative potential can be controlled automatically in dependence on one of these values.—*January 28th*, 1932.

366,431. September 3rd, 1931.—ELECTRIC CONTROL SYSTEMS EMPLOYING THERMIONIC VALVES OR THE LIKE, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2.*

The electric control system described in this specification relates more particularly to systems in which the supply of current from an alternating current source to a load circuit is controlled in response to the position of the body of an operator. The operation of the system will be clearly understood from the following explanation. The value of the condensers A and B is so chosen that normally a slight negative potential is impressed upon the grid C so as to render the discharge device D non-conducting. When an observer approaches the metal plate E, or some portion of his body comes in proximity thereto, the



capacity of his body completes a parallel circuit around the condenser B, as illustrated by the equivalent circuit at F. This results in a decrease in impedance between the grid and earth, with the result that the potential of the grid is increased with respect to its cathode and the discharge device D is made conducting to operate a window display, for example. It is, of course, obvious that, when the observer passes on, the control grid will again become negative and the display device will be de-energised at the beginning of the next half-cycle. If the capacity at E, F is increased sufficiently by the presence of an observer, a change in phase between anode and grid potentials occurs, but such a change, while assisting in the obtaining of the effect desired, is not essential to the operation of the arrangement. G is the load and H the primary of the transformer feeding the discharge valve.—*February 4th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

WEDNESDAY, MARCH 30TH.

NEWCOMEN SOCIETY.—At Prince Henry's Room, 17, Fleet-street, E.C. 4. "Roman Mining in Britain," by Mr. G. Clement Whittick. 5.30 p.m.

THURSDAY, MARCH 31ST.

INSTITUTE OF MARINE ENGINEERS.—The Minories, E.C. 3. Lecture, "The Salvage of ex-German War Vessels at Scapa Flow," by Mr. E. F. Cox. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "The Change-over of Low-tension Distribution Systems from Direct-current to Alternating-current," by Messrs. H. Bladen and A. C. MacQueen. 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, S.W. 1. "Modern Constructional Practice in Sewerage and Sewage Disposal," by Mr. A. H. S. Waters. 6.30 p.m.

FRIDAY, APRIL 1ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Development in Electrically Welded Fabrication," by Mr. E. P. S. Gardner. 7.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—St. John-street Chambers, Deansgate, Manchester. "The Lay-out of Machines and Small Tools for Economical Production," by Mr. W. Core. This meeting takes the place of that announced for March 25th.

MONDAY, APRIL 4TH.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL).—At the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. "Ein neuzeitliches Kesselsystem nach dem Zwangumwalz-Verfahren, System La Mont" ("A Modern Steam Boiler Construction with Forced Circulation, on the La Mont System"). The lecture will be illustrated with lantern slides. By Herr Dr.-Ing. A. Th. Herpen. 6 p.m.

WEDNESDAY, APRIL 6TH.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-EASTERN BRANCH.—Mining Institute, Neville Hall, Newcastle-upon-Tyne. "Industrial Conditions in Russia," by Mr. John Fearn. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Light Sensitive Cells in the Service of Man," by Dr. F. H. Constable. 8 p.m.

SOCIETY OF GLASS TECHNOLOGY.—In the Science Museum, South Kensington. "Statistical Methods of Handling Test Results, with Special Reference to the Testing of Glassware." The discussion will be opened by Mr. Bernard P. Dudding. 7.30 p.m.

FRIDAY, APRIL 8TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Joint Meeting of the Meter and Instrument Section and the Wireless Section. "Some Acoustic and Telephone Measurements," by Mr. H. R. Harbottle. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. Informal meeting. Discussion, "Training for Management," introduced by Mr. T. G. Rose. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: MIDLAND BRANCH, GRADUATES' SECTION.—Chamber of Commerce, New-street, Birmingham. "Bridge Construction," by Dr. C. H. Shirley Smith. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "The Design and Manufacture of Taps, with Notes on Screwing Dies," by Mr. W. Wood. 7.30 p.m.

TUESDAY, APRIL 12TH.

INSTITUTE OF MARINE ENGINEERS.—The Minories, London, E.C. 3. "Lubrication of Diesel Engines," by Engineer Lieut.-Commander H. J. Nicholson. 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C. 2. Annual general meeting. 7.30 p.m.

THURSDAY, APRIL 14TH.

INSTITUTE OF MARINE ENGINEERS.—The Minories, E.C. 3. Junior Section meeting. "Practical Hints on the Operation and Maintenance of Marine Electrical Machinery," by Mr. D. M. Cathcart. 7 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. Annual general meeting and open discussion on "Welding, Brazing, and Soldering." 7.30 p.m.

FRIDAY, APRIL 15TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Rocket Propulsion," by Dr. Herbert Chatley. 7.30 p.m.

FRIDAY, APRIL 22ND.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, S.W. 1. "The Film Lubrication of the Journal Bearing," by Messrs. R. O. Boswall and J. C. Brierley. 6 p.m.

TUESDAY, JULY 5TH, TO SATURDAY, JULY 9TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Royal Show at Southampton.

LAUNCHES AND TRIAL TRIPS.

CONISBOROUGH, steel lighter; built by Richard Dunston, Ltd., to the order of Hudson, Ward and Co., Ltd.; dimensions, 82ft. 6in. by 19ft. by 8ft. 9in.; to carry grain; launch, March 19th.

LAKESHELL, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of Dominion Tankers, Ltd., Toronto; dimensions, 260ft., 43ft. 3in.; to carry petroleum in bulk. Engines, triple-expansion; constructed by the builders; launch, March 19th.

CONTRACTS.

THE VAUGHAN CRANE COMPANY, Ltd., Manchester, has obtained an order for the supply of a 120-ton four-motor overhead electric traveller for the Loch Tummel power station of the Grampian electricity scheme.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has recently received an order from Ransomes, Sims and Jefferies, Ltd., for the complete control equipment for nine trolley omnibuses for the Tees-side Railless Traction Board. Another order, received from the Brush Electrical Engineering Company, Ltd., calls for the supply of the electrical equipments for eight new cars for Ilford Corporation Tramways.

THE INSTITUTION OF MINING ENGINEERS.—The Council of the Institution of Mining Engineers has awarded the "Mavor and Coulson" Travelling Studentship of £300 for 1932–33 to Edward James Kimmins, B.Sc. (Mining), of Birmingham University. The successful candidate is required to devote one year to the special study, by underground investigations, of the methods practised in the actual mining of coal and in the transport of coal from the face to the main mechanical haulage, in Great Britain, the Continent of Europe, Canada and/or the United States, and to follow a prearranged itinerary specifying the collieries to be visited.

AN AIR-OPERATED VICE.—Since we described in our issue of February 26th two air-operated vices made by Alfred Herbert, Ltd., of Coventry, we have been informed that yet another type has been placed on the market by the same firm. The new tool is intended to replace the former type and has now been adopted as a standard product, and patented. The operation of the vice is similar to that of those we described when they were shown at the British Industries Fair. The tool is available in two sizes, with 6in. or 8in. jaws, the maximum jaw openings being respectively 8in. and 9½in. The rear jaw is movable and is located in position by means of serrations; bolts hold it firmly in place at the desired jaw opening. The front jaw has a ½in. movement, and is air operated.

BELFAST ASSOCIATION OF ENGINEERS.—The annual dinner of the Belfast Association of Engineers, which was founded in 1892 and has now 309 members, took place on Saturday, March 14th, at the Carlton, Belfast. Over 180 members and guests were present and the chair was taken by the President, Mr. Robert Craig, M.I. Mech. E. The toast of "The City and Trade of Belfast" was proposed by the Lord Mayor of Belfast, Sir Crawford M'Cullagh, and the Recorder of Belfast, Judge Thompson, responded. In submitting the toast of "Kindred Associations," the President extended a warm welcome to Brigadier-General Magnus Mowat, C.B.E., Secretary of the Institution of Mechanical Engineers, and to Mr. D. Mellon, A.R.C.Sc., I.A.I.C., President of the Engineering and Scientific Association of Dublin. The toast of "Our Guests" was given by the President, and Mr. R. D. Herdman, D.L., and Mr. D. Mellon replied. Mr. David Adams, referring to the Silent Valley water supply scheme, said that the work had now arrived at a stage at which completion in a few months could be counted upon, and it was hoped that a member of the Royal Family would perform the opening ceremony. The President, Mr. Robert Craig, was thanked by the Lord Mayor for his chairmanship, after which the meeting was adjourned for music and dancing. All the arrangements were excellently carried out by Mr. Edwin Dempster, the Honorary Secretary of the Association.

By arrangement with Reuter's Engineering Service, THE ENGINEER contains the latest news from all parts of the world which is likely to be of interest to engineers.